SEPTEMBER 11, 1961

missiles and rockets

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THE MISSILE/SPACE WEEKLY

Magnafluxing Minuteman Case at GE

Nuclear Tests Will Reshape U.S. Missiles . . .
NASA Nears Incentive-type Contracts . . . . .
GE Ready to Make Big Solid Motor Cases . . 27

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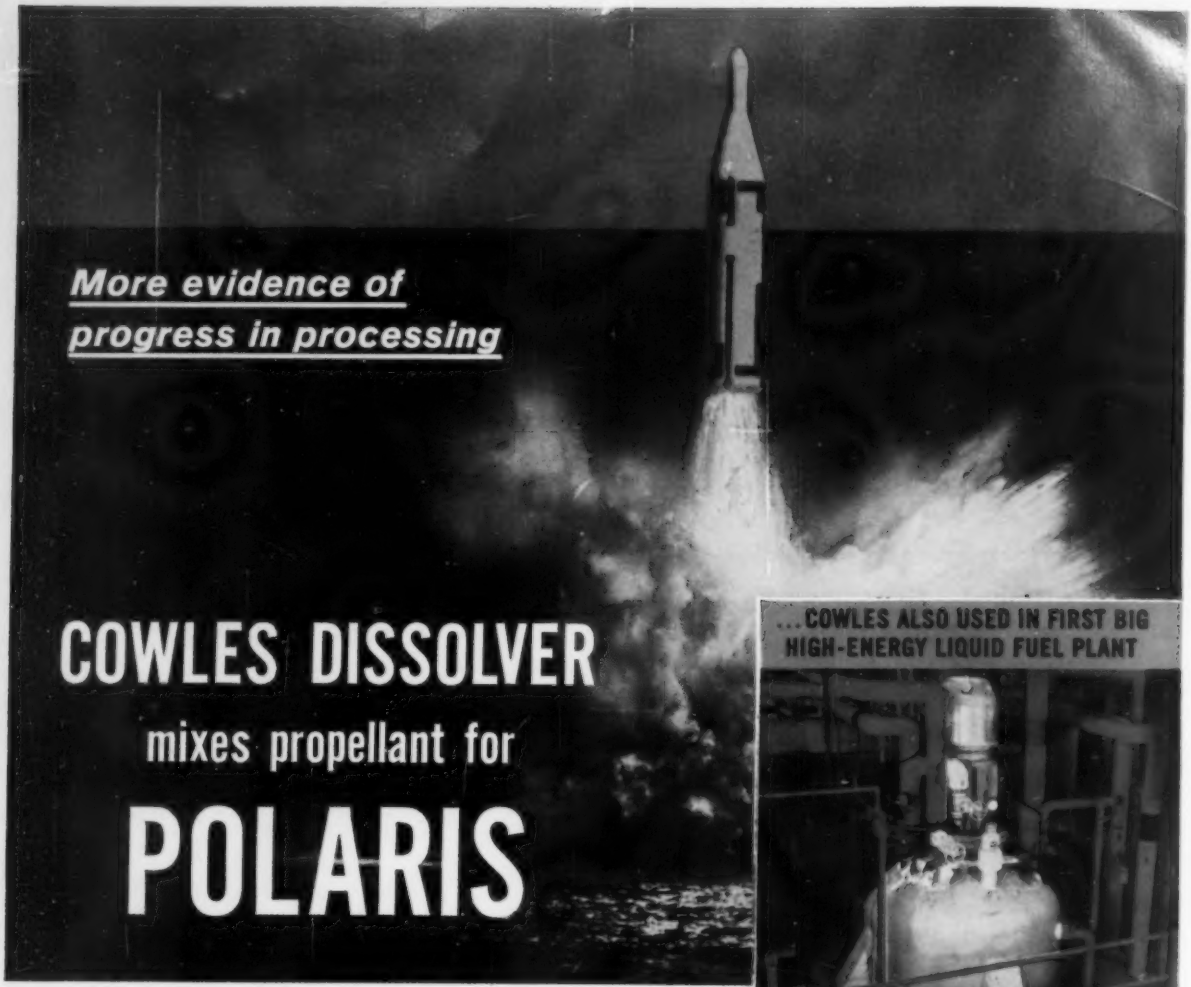

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434-A

JET TEST BOAT. Boeing jet-powered research hydroplane, capable of speeds up to 100 knots, is newest addition to Boeing equipment devoted to advancing man's knowledge. Aqua-Jet will be used to test experimental hydrofoil designs. Test model is suspended between prows from structure which controls action of model being pushed through water. These hydrodynamic design studies are typical of expanding Boeing efforts in marine field, which include building a hydrofoil patrol craft for U.S. Navy.

Capability has many faces at Boeing

CARGO-JET. Boeing C-135 cargo-jet, first of 30 ordered by the Military Air Transport Service, has already been delivered. These 30 C-135s will provide MATS with work capability equivalent to 100 propeller-driven transports.

SUPERSONIC transport model being tested in Boeing wind tunnel. Boeing is investing substantial sums in supersonic transport research. Future skyliners would be able to fly from New York to London in less than three hours.

SPACE GLIDER. Drawing of Dyna-Soar, U.S. Air Force manned space glider designed to rocket into space, then re-enter earth's atmosphere for conventional pilot-controlled landing. Dyna-Soar is being developed by U.S. Air Force in cooperation with NASA, with Boeing as prime contractor for both the system and the glider.

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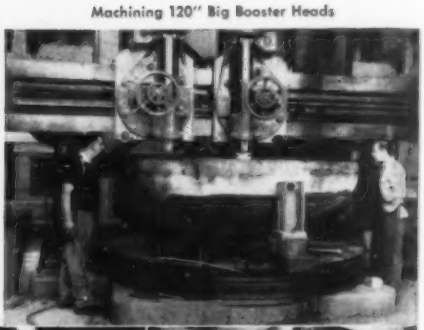

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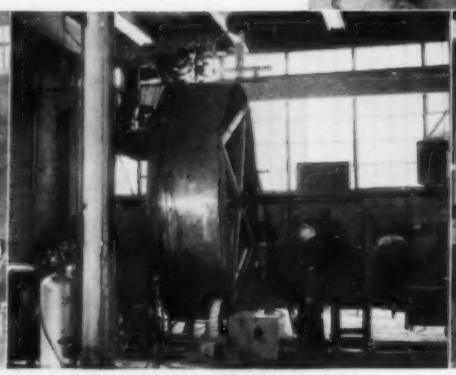

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missiles and rockets

Volume 9, Number 11 September 11, 1961

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THE COVER

Minuteman first-stage case is minutely inspected with extended carriage arrangement at GE's Evendale plant. Company is ready to turn out huge solid cases. See p. 24.

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letters

Apollo Guidance

To the Editor:

As a Program Planner vitally interested in the *Apollo* Program, I would like to call to your attention two items in curious juxtaposition in your Aug. 14 issue. Page 37 ("Prospector Getting Hard Second Look") says that Dr. C. Stark Draper's MIT Instrumentation Laboratory "is the oldest member of the *Apollo* contractor team. The *early* selection of the guidance-navigation system contractor was required because the guidance system development is basic to the overall *Apollo* mission." This certainly contains a strong implication that the guidance and navigation is one of the critical long-lead items on *Apollo*, an implication the writer agrees to heartily.

Page 38 ("Guidance Adequate for Soft Landing"), however, should banish any such thoughts. It contains the assertion by the popular Dr. Draper "that guidance and control will never be a limiting factor in any future U.S. space effort. When the rest of the technology is ready for another step forward, it will find G&C ready and waiting."

Since G&C is generally interpreted to include guidance and navigation, the minor difference in terminology doesn't help to clarify this paradox.

In any case, the writer welcomes NASA's early placement of the guidance and navigation contract for *Apollo* and suggests that Dr. Draper might have added to his remarks at Stanford "if the go-aheads are early enough."

R. J. Mehling
Advanced Design Program Planning
Martin-Baltimore
Middle River, Md.

In his speech, Dr. Draper was referring in general terms to the state of the art in G&C. Obviously even though the art is relatively well advanced, guidance for a program of the Apollo type must be developed early.—Ed.

Assignment: Survival

To the Editor:

In your excellent Aug. 14 editorial you question: "What can the president of the electronics component firm do?"

Mr. Jerome Taishoff, president of the Mycalex Corporation of America, has been deeply aware of the dangers which face the United States and the entire free world. He wanted to do something that would help wake up the country and bring some knowledge of the frightening future that awaits us unless we take effective action.

He had read and been greatly moved by Gen. Alexander P. De Seversky's latest book—"America, Too Young to Die." Of de Seversky's book, one reviewer said the reader opens "scoffing and closes scared." Nevertheless, this reviewer and most of the others recommend that de Seversky's book be read by every thinking American.

Mr. Taishoff felt that if he could make prominent opinion-makers aware of the thesis of the book he would have made a contribution to the awakening of the United States. With this in mind he has sent to date approximately 900 copies of "America, Too Young to Die," personally autographed by the author, to individuals whose business interests and affiliations extend into every phase of the avionics/electronics industry, and to others who influence national and industrial thinking.

De Seversky contends, among other things, that the broad industrial electronics base of America is vital in developing a powerful defense against nuclear attack. Further, if properly utilized it will enable us to overtake the USSR in aerospace power and thus protect ourselves, because in this field we unquestionably lead in the art as well as in the techniques of production.

Jerome Taishoff hopes that he is making a contribution to the future of America. He plans to keep right on sending out the book to those who will read it and, he hopes, act.

Shippen Geer
President
InterOcean Publicity, Inc.
New York City

To the Editor:

Your editorial should be read and *understood* by everyone associated with the space industry.

I represent a support facility (communications) serving a major missile/space contractor. The pride of accomplishment of their efforts is felt by our craftsmen and management.

Unfortunately, a large segment of the general public views these industries as cost-plus monsters devouring hard-earned tax dollars.

Few people seem to realize that Missile/Space companies invest vast sums of capital money in research and development, feasibility studies, etc.

My own opinion of this industry has changed after closer association with top-flight managers that I have found in many instances to be dedicated to National Survival.

E. M. Armstrong
San Francisco

Splitting Gimbals

To the Editor:

The word "gimbal" used in the table on page 113 of M/R, July 17 is misspelled, I believe. My dictionary says "gimbals." Getting a gimbal should be about as difficult as getting a scissor or a trouser.

By the way, you will be terribly interested to learn that a gimbal ring is "a single gimbal, as that by which the cockeye of the upper millstone is supported on the spindle." Does this make you gimble?

Charles E. Dills
Washington, D.C.

P.S. I think you have a very good maga-

zine. I write for a technical magazine myself, so I have some reason to think I may make some judgment.

The word "gimbal" was used three times in the chart—in every case as an adjective. Like it takes two scissor blades to make a scissors, two trouser legs per pair of pants. Will gamble this makes you gambol. —Ed.

Vanishing West Ford?

To the Editor:

The current squabble between the radio astronomers and the Military over the seeding of a belt of reflecting needles for scatter communication might be resolved by using a metalized high-vapor-pressure organic material. The needles could be designed to dissipate as gas and dust over a 30-to-60-day period. Meanwhile, the Military could have tested the concept. As this is supposedly more a test than an initially permanent system, this approach ought to make all factions reasonably happy.

Ed Dingeman
Littleton, Colo.

Inadequate EED's

To the Editor:

"MR-4 Winds Up Suborbital Series" (M/R, July 31, p. 16) reports that NASA officials have fluffed off the escape hatch malfunction, possibly caused by R-F energy initiating the electro-explosive devices, as if it were relatively unimportant. Perhaps, to the overall program, it was. But certainly not to the individual (Astronaut Grissom) whose life hung in the balance or to (the scientists) who lost the information in the capsule.

Maybe NASA is determining the cause. Even so, it seems to me that NASA should be aware of the seriousness of the effect of electromagnetic radiation on the functioning of electro-explosive devices (EED's) being used in missiles, etc. They should be aware of the fact that the Air Force, Navy and Army Ordnance have been actively engaged in studying R-F's adverse effects on EED's.

I can speak with experience, having been actively involved in such work for three or four years. Also, I happen to know that NASA does not have personnel who have such experience and therefore it can't cope with the technical aspects of the situation.

This disturbs me, since nickel-and-dime EED's are finding their way into million-dollar programs. They are inadequately manufactured, tested and qualified.

I know this problem is quite complex, but considering the exposure of such services to the present-power electronic apparatus and the more powerful of the future, NASA should at least do something more than "put it down as an operational problem not requiring any design changes."

S. C. Piccoli
Philadelphia

Hunting for the Snark

To the Editor:

In looking over the recent M/R Fifth Annual World Missile/Space Encyclopedia, I could not find the *Snark* listed. I would be interested to know why it was not mentioned.

J. McWilliams Stone
The DuKane Corp.
St. Charles, Ill.

The Snark program is being discontinued.—Ed.

From Fiftieth State

To the Editor:

Because there's been a great deal of talk lately concerning establishment of a major missile base in Hawaii, you may be contemplating some sort of a story on the 50th state.

We hope so, and we hope that the attached economic report (just off the press) may be of use to you.

Our "Shoemaker Report" circulates widely among bankers and businessmen on the mainland—but this is the only copy we are sending to any missile/space engineering magazine. Reason: Pacific Missile Range friends assure us that MISSILES AND ROCKETS is the leading publication in the field.

Aloha,
Barbara Pike
Bank of Hawaii
Honolulu

Titan II Guidance

To the Editor:

Reference is made to the article on the *Titan II* system in the June 19 issue of M/R.

The article states that IBM was responsible for the development of the complete guidance checkout and launch equipment for the system. In order to set the record straight, it should be stated that IBM developed only that portion of the ground checkout equipment associated with the airborne computer. The remainder, which is by far the majority, was developed by AC Spark Plug.

John Sheldrick
Senior Project Engineer
AC Spark Plug Division
General Motors Corp.
Milwaukee

Youthful Appraisal

To the Editor:

I found your Aug. 14 editorial a very well done piece of work. It said what should have been said a long time ago. If more articles like this were written, it might do a lot of good. The American people have to finish what President Kennedy started. If President Kennedy hadn't done what should have been done a long time ago, we really would have had woes.

Bob Goldich
(Age 10¾)
Palo Alto, Calif.

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the HEART

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1. This system is ideally suited to provide power and cooling for manned space vehicles. High energy cryogenic propellants offer maximum specific impulse, plus a heat sink capability making possible a simple and reliable cooling system.
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The Countdown

WASHINGTON

'Peaceful' Space Hopes Dead

The United States is abandoning hope of arriving at a United Nations agreement with Russia to use space for "peaceful" purposes. This is apparently the reason why NASA is now disbanding its Office for U.N. Conference, headed by former *Vanguard* boss John P. Hagen. Hagen's group was formed almost two years ago in support of the proposed U.N. Committee on the Peaceful Uses of Outer Space, which never has been organized because of Russian insistence on dominating the various subcommittees. One of the prime objectives of the U.N. committee was to sponsor a world-wide conference on space—a prospect that now seems dead, indeed. Hagen is expected to take another post within NASA.

Tomahawk: A New Attack on Tanks

The Army is understood to have Martin studying a new light antitank missile called *Tomahawk*. The missile presumably would be a successor to such antitank missiles as *SS-10* and *Entac*.

Fabmids Decision Pending

A decision on the next step in the development of *Fabmids*—the Army's proposed field antimissile missile—is expected within a matter of months. The story being passed along is that the decision could come before Jan. 1. *Fabmids* is expected to interest NATO.

Zeus at Bat at Pt. Mugu

The Army is about to open the next major phase in testing *Nike-Zeus*. All three stages of the Western Electric antimissile missile are to be fired for the first time in flight tests at Pt. Mugu, Calif. The tests originally were scheduled to begin last month. The new target date: before mid-September.

On the Pad

NASA is ready to make another attempt this week to orbit an unmanned *Mercury-Atlas* capsule. Problems with the *Atlas* programer that forced postponement of the launch Aug. 22 now are said to be cleared up. . . . Upcoming in October: the first *Saturn* flight; an Air Force *Blue Scout; Ranger II;* the first *Orbiting Solar Observatory* (aboard an *Atlas-Agena B*), and an ionosphere electron-density satellite.

INDUSTRY

Polaris A-3 Still 'A-OK'

Published reports that the 2500-mile *Polaris A-3* is in trouble and may have to settle for a shorter range are being flatly denied. COUNTDOWN is told that although there have been problems with the hotter propellant—as shown by some mixing plant explosions recently—the Navy still expects to meet the 1964 operational date for the *A-3* with no compromise in range.

NASA and Basic Research

Some NASA officials hoping to beef up the nation's basic research capacity are considering asking Congress for authority to build laboratories and other facilities at educational institutions, and to fund direct fellowships.

Front Office

Minneapolis-Honeywell and the British Aircraft Corp. are forming a joint organization—BAC-Honeywell Inertial Guidance—Europe, headquartered in Paris, to develop, manufacture and market inertial systems for missiles and aircraft. . . . Lockheed now has authority to issue fixed-price purchase orders and subcontracts up to $100,000 without prior government approval (previous limit was $25,000). . . . Rocketdyne Division of North American Aviation has set up three new product operations—Research, Nuclionics and Space Engines.

Florida Turns On Hard-Sell

With the expansion of Cape Canaveral under way for the U.S. lunar program, Florida industrial promoters are banging on the doors of misisle/space firms to lure them southward. The huge NASA buildup in facilities is expected to bring a wholesale influx of propulsion, electronics and service companies into the Orlando-Cape area.

R&D Intelligence

Henri Hodara of Hallicrafters thinks re-entry communications "blackout" can be licked by using a magnetic field to open up a "window" in the plasma sheath through which radio waves can pass. . . . AEC scientists expect *Vela Hotel* to be able to detect a one-megaton nuclear blast in space at three times the earth-sun distance—unless background radiation introduces a new element of uncertainty.

INTERNATIONAL

British Missiles to Germany

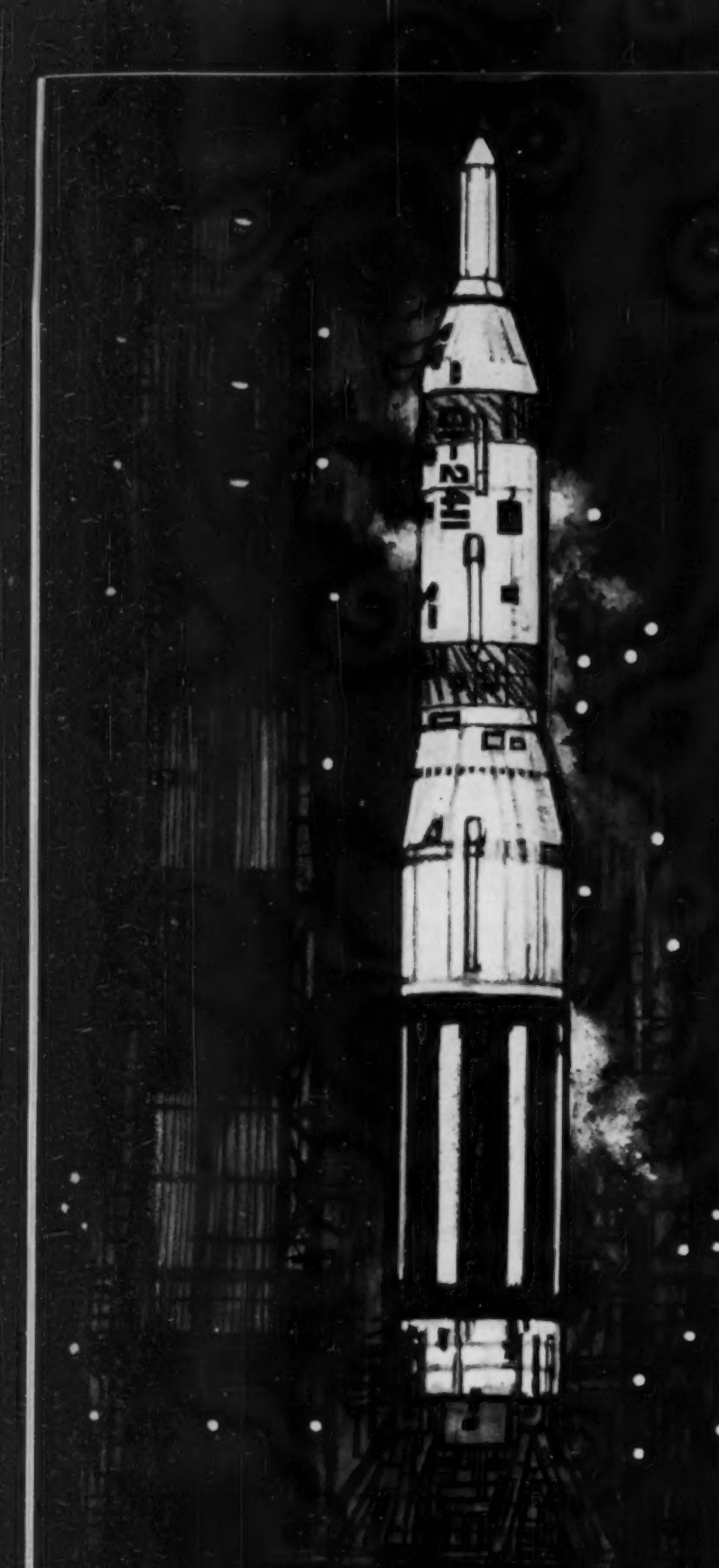
The British are beefing up their missile forces in West Germany. The Royal Artillery's 36th Guided Weapons Regiment equipped with *Thunderbird* antiaircraft missiles is being redeployed this month. There are two *Corporal* regiments at Dortmund, Germany.

Resentment Toward Blue Streak

COUNTDOWN hears that French technicians involved in the European Space Club are expressing rather strong opinions against using the British *Blue Streak* as a satellite booster. They also resent the choice of Woomera as the test center and the reported choice of Farnborough as a center for space research.

Overseas Pipeline

A new radio telescope weighing 1350 lbs. and more powerful than Britain's Jodrell Bank will go into operation at the end of next month at Parkes, New South Wales. . . . The Dutch and Belgian governments are planning to build a $2.8-million radio-telescope 20 times more discriminating than Jodrell Bank. . . . Some British officials are worrying that U.S. plans for global communications satellites will ruin Britain's international communications business.



TAMING THE WILD BLUE YONDER

Primary responsibility for research, development, production, testing and evaluation of the Air Force's newest weapons systems—this is the mission of the recently created Air Force Systems Command. To its men—our defense architects—this mission presents the eternal challenge . . . that of taming the wild blue yonder.

AFSC

In pursuit of this challenge AFSC must call upon the vast resources of industry and of education, as well as those of the military. AC Spark Plug is being called upon to develop and produce the small, yet highly accurate inertial guidance system for the TITAN II. This is but one example of American industry and government working together so peoples of the world may live together—in peace.

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The Missile/Space Week

All-DOD Purchasing Agency to be Set up Soon

The Defense Department moved last week toward establishing a Defense Supply Agency that eventually could handle all common procurement for the Armed Forces.

The long-range effect of the move on the Missile/Space Industry was not immediately clear.

Some central procurement of electronic supplies is expected. Another possibility: rocket fuels.

Senate to Probe Program

The Senate Space Committee will hold a series of hearings starting Sept. 26 on the national space program.

Sen. Robert S. Kerr (D-Okla.), committee chairman, said the hearings will be concerned initially with a review of the *Saturn* and *Centaur* launch vehicle projects.

This will be followed, he said, by an examination of the communications satellite program, including the relationship between NASA, other government agencies and industry.

Other aspects of the space program will also be considered.

Lockheed's Gross Dies

Funeral services were held last week for Robert E. Gross, chairman of Lockheed Aircraft Corp., who died Sept. 3.

GROSS

Gross, who was 64, built Lockheed into the 28th largest industrial firm in the nation. He began with a bankrupt aircraft company purchased by himself and a group of associates in 1932 for $40,000.

Headquartered at Burbank, Calif., Lockheed now employs 66,500 persons in aircraft, missiles, spacecraft, electronics, shipbuilding and other fields. It has net assets of $548 million and gross sales of more than $1 billion.

(See editorial, page 46)

'Surface Effect' Vessel

The Maritime Administration has let a design contract for a "surface effect ship" envisaged as the possible forerunner of surface-skimming warships.

The craft, which will travel above either water or land on a cushion of air, will be designed by Vehicle Research Corp., Pasadena, Calif., under a $370,000 contract. Construction may start late next year.

Leashed Bloodhounds at Farnborough

BLOODHOUND antiaircraft missiles were displayed at Farnborough (see p.18) as Bristol/Ferranti revealed that Bloodhound II could kill at "well under 1000 ft."

Japan Working on Mu Rocket

The Japanese are reported to have the development of a huge scientific *Mu* rocket under study. It will be the successor to the 66-ft. *Lambda*.

Few details of the *Mu* are available. However, it is reported to be designed to reach altitudes of about 2600 miles.

The four-stage *Lambda* is expected to be completed about 1963.

Stahr Calls for Imagination

Army Secretary Elvis J. Stahr called on industry last week to use "greater imagination" in developing new Army weapons.

"Eschew the conservative approach," Stahr told some 4000 military men and industry representatives attending the 1961 annual meeting of the Association of the U.S. Army in Washington.

The annual AUSA report noted with careful enthusiasm the recent increases in Army funding for modern equipment and increased manpower. However, it added that more support is needed for CBR development and *Nike-Zeus* should be put into production.

One of the convention's highlights was the public display of "BIRDIE" —the Army's new vest-pocket air defense system. (See p. 21.)

NASA Gets Saturn Plant

NASA announced that it is taking over a government-owned plant at Michaud, La., for use as a site to produce *Saturn*-class vehicles.

The plant will be used to build the first stage of the *Saturn C-1* booster and the two-F-1-engine first stage of advanced *Saturn* vehicles.

When in full production it is expected to have at least 15,000 employees.

No contractor has yet been selected to build the stages. A date for a bidders conference has been delayed by NASA indecision as to whether one firm should be picked to build

WIDE ANGLE FLOATED RATE INTEGRATING GYRO FOR CONTROL APPLICATIONS

Designed for strapdown control applications, this miniature wide angle precision gyro provides accurate and reliable performance in extreme missile environments.

A newly developed high viscosity damping fluid with good low temperature characteristics permits large angular inputs without loss of reference and eliminates the need for paddle type damping devices. Low uncompensated drift levels are obtained through the use of externally controlled adjustments of mechanical mass unbalance and fixed torque drift. A unique torquer with external adjustments makes possible high torque linearity including at the "off null" position. The spin motor will operate satisfactorily from a three phase or single phase 400 cps power supply.

Actual test data taken on a group of these gyros demonstrate the capability of this device as the most accurate and stable control gyro now available. Typical test results include the following average values:

Uncompensated mass unbalance level—0.35°/hr/g avg.; Uncompensated restraint level—0.4°/hr avg.; Torquer linearity 0.017% avg. proportional from 0.1°/sec to 5°/sec.

TYPICAL CHARACTERISTICS

Angular momentum (gm cm²/sec.)	100,000
Operating temperature	180°F*
Torquer scale factor (°/hr/ma)	800
Input angle	Up to 30 degrees
Transfer function (mv/mr)	3.75 at gyro gain of 3.0
Dimensions: lengths	3.56"
body diameter	1.98"
mounting diameter	2.15"
Weight	1.2 pounds

*lower operating temperature as required

Write for complete data

KEARFOTT DIVISION
GENERAL PRECISION, INC.

Little Falls, New Jersey

both stages of the booster.

It is also reported that a contract award for the four-J-2-engine second stage of the *Saturn C-3* will be announced in the next few days.

Firms in the running include Aerojet, General Dynamics-Astronautics, Douglas and North American.

Ranger Flight Useful

Ranger I fell into the earth's atmosphere and burned up on Aug. 28.

Launched on Aug. 26 from Cape Canaveral, the lunar spacecraft made 101 orbits of the earth and traveled over 3 million miles.

NASA said that the flight proved that the spacecraft orientation equipment, communications and electronic systems worked well.

Ranger I's short lifetime was due to a malfunction in the *Agena B* stage, which failed to send the spacecraft into the long-earth orbit planned.

Late Contract Items:

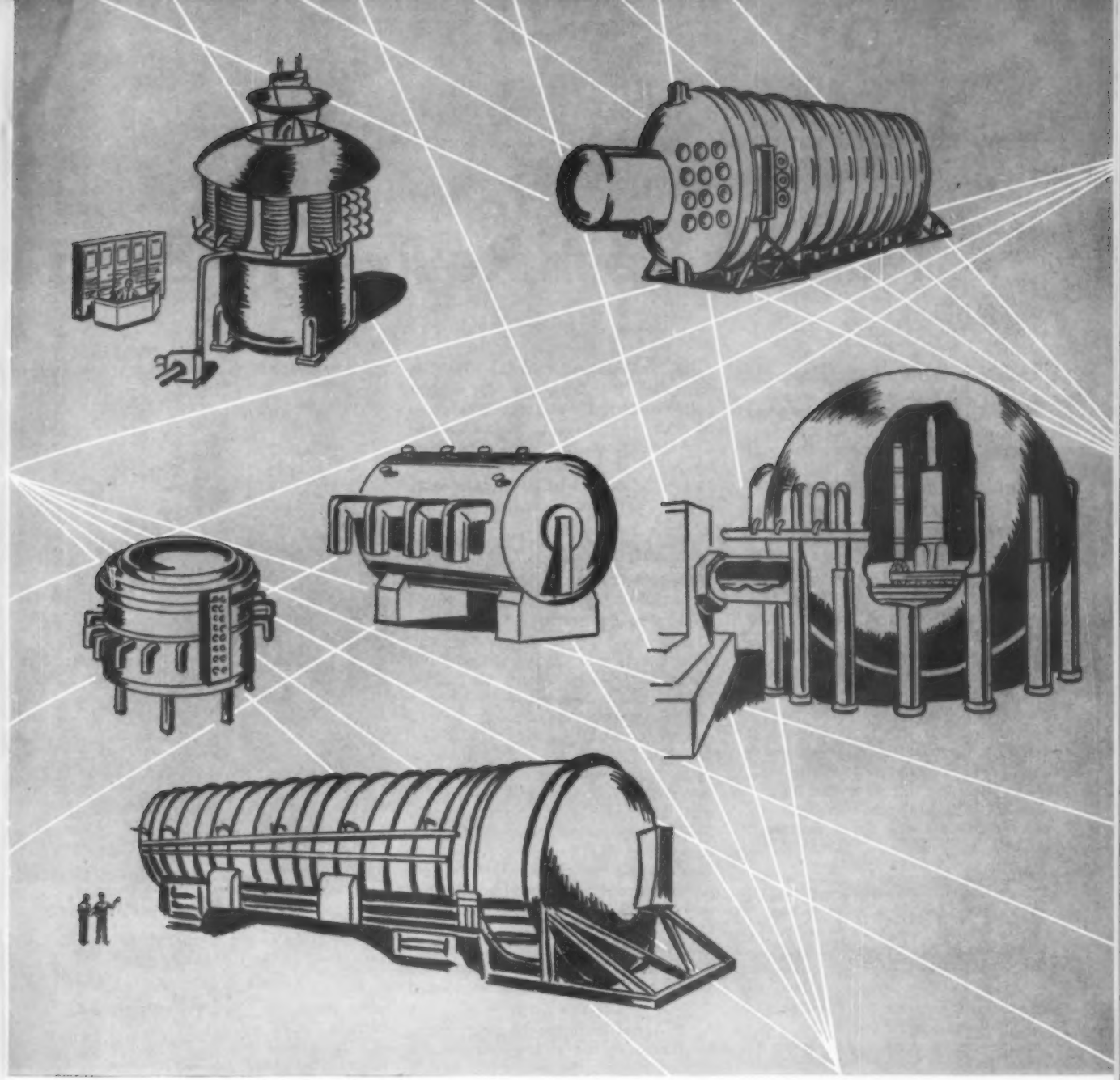
• **Martin Co.,** Baltimore — A $99,000, six-month Navy study contract for design of advanced submerged submarine navigation aid. System is proposed for installation in AUTEC. Both passive and active aids will be considered. Martin said findings to date suggest best navigation aid may use a "bottom bounce" method of projecting underwater sound.

• **Martin Co.,** Baltimore—A $310,000 NASA contract to build some 50 heat exchanger units for *Saturn C-1* boosters.

• **Avco-Everett Research Laboratory** — A $1,582,824 subcontract from Bell Telephone Labs to conduct a program associated with identification techniques for *Nike-Zeus*.

• **Thiokol Chemical Corp.**—A $1,033,000 Navy award for production of *Bullpup B* Model LR 62 RM-2 packaged liquid engines. First flights of the "B" powered with this engine will be made from A4D carrier-based aircraft.

• **Vitro Engineering Co.**—Picked as contractor to AEC (amount to be negotiated) for architectural and engineering design contract for nuclear rocket engine maintenance and disassembly building. The building will be the first component of the National Nuclear Rocket Development Center, which will probably be built at the AEC's Jackass Flats test site.



Down-to-Earth Space Chamber Designs

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New threats, chances . . .

Nuclear Test Revival to Bring

U.S. as well as Soviets can make good use of more explosions; maneuvers may be aimed at Polaris subs

by James Baar

THE RESUMPTION of nuclear testing by Russia and the United States is certain to result in radical changes across the board in U.S. plans for development and deployment of missiles.

Pentagon specifications and industry proposals will have to be sharply adjusted to meet the problems and opportunities that will be created by the coming decrease in payload weights and the increases in payload power.

This is the still somewhat obscured but basically life-and-death significance of the loosing of a Soviet nuclear explosion in a remote corner of Kazakh Sept. 1.

• **Dread 'first' due?** — Meantime, the closely related Russian maneuvers in the Barents and Kara Seas could be the opening gun in an undeclared sea war against the *Polaris* submarine fleet.

The Russians strongly hinted that the maneuvers—running from Sept. 10 to Nov. 15—will include the use of nuclear-tipped missiles. The Soviet Defense Ministry has warned "the owners of . . . foreign ships that it will not bear responsibility for any material damage that might be caused to ships or planes crossing the danger zone."

The Barents and Kara Seas, as well as the neighboring Norwegian Sea, have long been considered to be likely deployment areas for *Polaris* submarines. With the sailing Aug. 28 of the Abraham Lincoln, the number of *Polaris* submarines within striking distance of the Soviet heartland has grown to five.

If Russia launches nuclear-tipped missiles in the Arctic war games, it will be the first time that such a missile has been launched with a live warhead under tactical conditions.

• **Underground harvest**—The data from these launchings are only a small part of the gains that Russia is expected to achieve by resuming nuclear tests in the atmosphere. But the gains from underground testing, in which many experts believe Russia has been secretly engaged for some time, are also impressive.

Nuclear underground testing is expected to make it possible for the United States to:

—Increase greatly the yield-weight ratio of missile warheads. This means that the punch of *Minuteman* and *Polaris* warheads can be increased. It also means that, as an alternative, ranges can be extended. And it means that highly mobile, land-roving ICBM's can be developed more easily.

—Test designs of nuclear warheads tailored to prospective and recently developed defense systems. This means that the United States no longer will have to rely on test data pre-dating the deployment of *Atlas* and *Polaris*—let alone *Titan, Pershing* and *Minuteman.*

—Develop possibly revolutionary types of nuclear weapons, particularly tactical warheads for use on the battlefield by small Army units. Also develop "cleaner" nuclear warheads that would enable commanders to confine damage to a specific target area.

• **Aerial bonuses**—Nuclear testing by Russia in the atmosphere, besides making possible the testing for the first time of new nuclear-tipped missiles and antimissile missiles from launching to detonation, also is expected to make it possible for the Soviets to:

—Develop great "Doomsday" warheads, ranging from 30 to 100 megatons. Despite some public disclaimers as to the military value of such warheads, they will enable Russia to make obsolete much of the planning and construction on U.S. fixed, hardened missile sites.

—Test the ability of hardened missile sites to withstand nuclear attack.

—Make all the advances that can be made from underground testing and perfect them further. This, of course, is of interest to Russia only if these gains have not already been made secretly during the test ban.

The Soviets detonated four low-to-intermediate-range nuclear devices in the first six days of their current test series.

• **Next move ours**—President Kennedy announced the resumption of U.S. underground tests after the third Soviet nuclear blast. The tunnels in Nevada where the underground tests will begin this month have been kept ready and improved since they were last used in 1958.

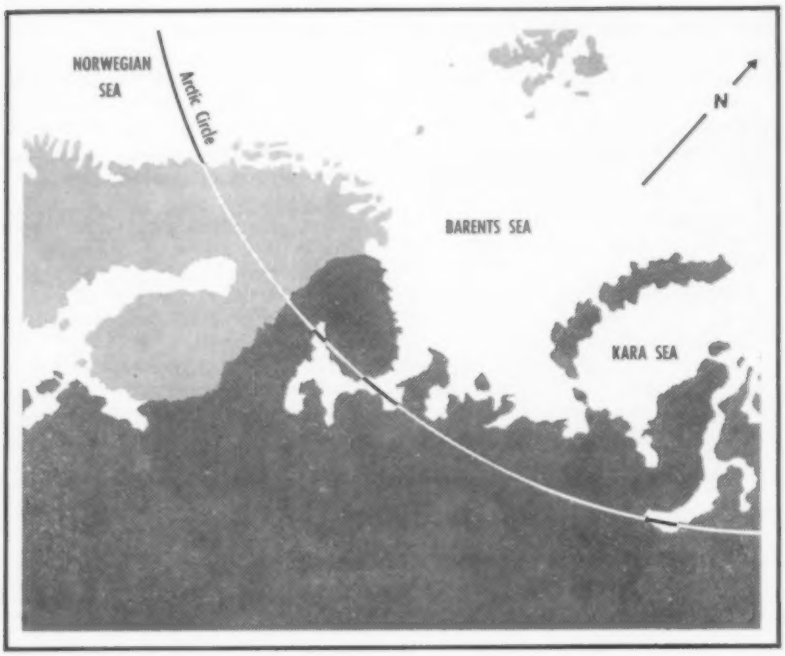
The AEC conducted a total of four underground tests in the 1958 series. The first U.S. underground test took place the year before. The last of the 1958 series was the biggest: about 20 kilotons.

There was no immediate indication

Reds Maneuver in

THE RUSSIANS are planning to conduct the world's first nuclear missile maneuvers

Drastic Missile Revisions



Polaris Stamping Ground

in the Arctic seas—one of the areas where the Robert E. Lee (left) and her sister Polaris-carrying submarines are believed to be on station.

how big the U.S. tests would be. However, AEC scientists have talked in the past of the possibility of conducting more than 100-kiloton tests underground—even in secret.

Because of the importance of the gains that will accrue from tests in the atmosphere, the United States is expected to follow Russia's lead and conduct tests there as well as underground.

• **Voices of warning**—Also, there is a serious question as to whether the United States could afford not to resume tests in the atmosphere that would at least match those conducted in Russia. As Sen. Clinton P. Anderson (D-N.M.), former Chairman of the Joint Congressional Atomic Energy Committee, put it:

"As it now stands, the Russians could go on and shoot 10 or 15 shots and finish a lot of their preliminary work (and) then announce: 'We'll quit if you do.'

"We must announce the program and stay with it."

Anderson was warmly supported by many key members of the Senate and House. A number of them have been pressing for months for U.S. resumption of tests, regardless of what Russia did openly, on the grounds that the Soviets probably were cheating.

The pressure had begun to mount last fall. At that time probably no one in authority put the problem more bluntly than AEC Commissioner Robert E. Wilson:

"Any country which decides to proceed with further testing and, hence, a systematic weapons improvement program, while we continue to observe a moratorium, is likely in a few years to take our place as the foremost nuclear power in the world."

At the time the nuclear test moratorium went into effect in 1958, the United States had conducted 153 nuclear weapon development tests and dropped the first two A-bombs on Japan in World War II. Russia was reported to have conducted 55 tests; Britain, 21. Since then, France has conducted four.

• **Lost ground**—However, the fact that the United States has conducted more tests than all other nations combined is not the full story.

Only twice has the United States ever launched a missile with a nuclear warhead and determined whether it would explode over a target. Both times occurred in the Pacific in August, 1958. The missile was reported to be a *Redstone;* the warhead in the megaton range.

Therefore, none of the great missiles—*Atlas, Polaris, Titan* and *Minuteman*—on which U.S. deterrent power will rest in the 1960's has ever been completely tested in the way that a rifle or an artillery piece is tested.

Finally, the vast complex of hardened ICBM bases is being built on the basis of calculations made with 10-megaton warheads in mind.

And, last but certainly not least, there is the intriguing question of how the 100-megaton warhead would be delivered. Soviet Premier Khrushchev has boasted that the same rockets that launched the *Vostoks* could be used. But there have been strong hints that the *Vostoks* themselves would be the carrier.

Hundreds of unmanned *Vostoks* could be put into orbit with their terrifying loads. Other *Vostoks* with men might help direct the space-to-earth battle at the desired time.

The meaning of the mushroom clouds rising near Semipalatinsk in Kazakh is clearly the beginning of a new and far more desperate lap in the East-West arms race. The goal: New and better missiles—and spacecraft. ¤

Incentive-type looms . . .

NASA Reviewing Costly Contracting P

Space agency joins DOD's drive to cut waste; most of problems blamed on the cost-plus-fixed-fee award

by Hal Taylor

NASA HAS BEGUN a review of its contracting procedures amid indications that the space agency will make use of incentive-type contracts for the first time.

The review was ordered by Administrator James E. Webb in an effort to cut R&D costs. Some firm results can be expected in the next few months.

Officials—already at grips with the problem—report that some cost-plus-incentive-fee contracts will be awarded in the near future. If these are successful, it is likely that more and more will be used to replace the current cost-plus-fixed-fee contracts which the space agency blames for most of its "high cost" troubles.

NASA thus is joining the Defense Department's attack on the wastefulness of government procurement. In June, DOD procurement officials served notice on defense contractors that some method must be found to cut costs.

Space agency officials wholeheartedly agree.

Ernest W. Brackett, director of NASA's Procurement and Supply division, said that the cutting of costs through better contracting methods is a "serious problem and one which we will have to do something about." He said that a full-fledged review of contracting policy has started and "we hope to come up with some ideas."

• **Root of trouble**—Prime target of the review is NASA's present policy under which contracts calling for the payment of costs plus some predetermined profit are used almost exclusively in procurement.

In Fiscal 1961, 83% of NASA's total procurement of $363 million was awarded on a cost-plus-fixed-fee basis. Cost-plus-firm fixed price contracts accounted for another 16%. The other 1% was split up among five other, similar cost-type contracts.

The primary advantage of incentive-type contracts is that the contractor receives a higher profit for savings in cost or superior performance. Conversely, his profit is reduced if the costs are too high or his performance is not up to standards.

The big problem in using such contracts is that a wealth of experience must be chalked up before the agency will have sufficient material with which to compare a contractor's cost claims and performance.

This is especially true for a comparatively new agency, like NASA.

Brackett refuses to say what changes in contracting procedures will result

HISTORY OF THE BIG BOOSTER DOLLAR (in millions of dollars)

	NASA FY '59	NASA FY '60	NASA FY '61	NASA FY '62	Total NASA	DOD through FY '61	DOD FY '62	AEC through FY '61	AEC FY '62	GRAND TOTALS
SATURN										
R&D	—	9.4	118.1	224.2	351.7		—	—	—	
Construction	—	—	46.5	39.7	86.2		—	—	—	
In-House	—	2.9	49.2	68	120.1		—	—	—	
TOTAL	—	12.3	213.8	331.9	558	101.3	—	—	—	659.3
NOVA-L										
R&D	10	24.2	40	57.3	131.5		—	—	—	
Construction	—	4.5	—	24	28.5		—	—	—	
In-House	—	—	.1	.1	.2		—	—	—	
TOTAL	10.0	28.7	40.1	81.4	160.2	.8	—	—	—	161
NOVA-S										
R&D	.6	1.7	1.3	3.1	6.7	—		—	—	
Construction	—	—	—	—	—	—		—	—	
In-House	—	—	—	.1	.1	—		—	—	
TOTAL	.6	1.7	1.3	3.2	6.8	—	62	—	—	68.8
ROVER										
R&D	3	4	8.7	25.5	41.2		—			
Construction	—	1.5	—	15	16.5		—			
In-House	—	—	.2	.2	.4		—			
TOTAL	3	5.5	8.9	40.7	58.1	7.2	—	124.1	51.75	241.2

HOW U.S. HAS SPENT more than $1 billion over the past two years—and has yet to fly a big space booster—is shown in this table compiled from recently published testimony before the Senate Space Committee. The table indicates that in the next year or two, under the accelerated moon effort, these four major programs will easily eat up $1-2 billion per year.

Procedures

from the review—other than to point out that procurement officials at the Goddard Space Flight Center are expected to award some cost-plus-incentive-fee contracts shortly.

Any other ideas, he says, will have to be checked first with legal counsel.

Other space agency officials said, however, that there is nowhere for NASA to go except in the direction of new types of contracts.

While admitting that the space agency's cost experience is small, they point out that NASA is chalking up some cost data on the *Aerobee* and *Scout* programs. This will also be increased as the *Saturn* and *Apollo* programs get rolling.

Among the types of contracts which they suggest NASA may be using in the future are the fixed-price incentive, cost-type incentive and Value Analysis.

The officials also said that there is a possibility that NASA may decide to inaugurate an entirely new type of contract. This could parallel the cost-plus-award-fee which the Defense Department is currently considering. Under that contract, a board of qualified judges could award up to 15% for exceptional performance—or deduct as much as 5% for poor performance. ⌘

Latest on Apollo Awards

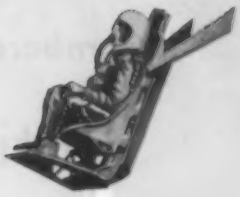
NASA has released details on Apollo spacecraft contracting procedures which indicate that more than one major contract will be awarded.

Space agency officials said that one firm will be selected—from those asked to submit bids by Oct. 9—to perform research and development for the spacecraft's command and service modules.

The firm will also be responsible for system engineering and systems integration for all other contracts which may be awarded in the building of the lunar landing spacecraft.

In addition to the contract for a guidance and navigational control system already given to Massachusetts Institute of Technology, other contracts will probably include an orbiting laboratory module, a vehicle adapter for earth-orbiting missions and the development of a propulsion module for lunar landing missions.

Still more contracts are expected.



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At Farnborough . . .

British Show Growing Array of Salable Missiles

Photos taken at opening of British industry's big annual exhibition reflect widened production ability

BRITAIN'S ionosphere satellite.

FARNBOROUGH, ENGLAND — British missile power went on display this last week at the Society of British Aircraft Constructors annual exhibition.

The Hawker Siddeley *Blue Streak* space booster dominated the display at the missile park. However, British Aircraft Corp.'s *Blue Water* received equal attention, particularly from visitors from the continent.

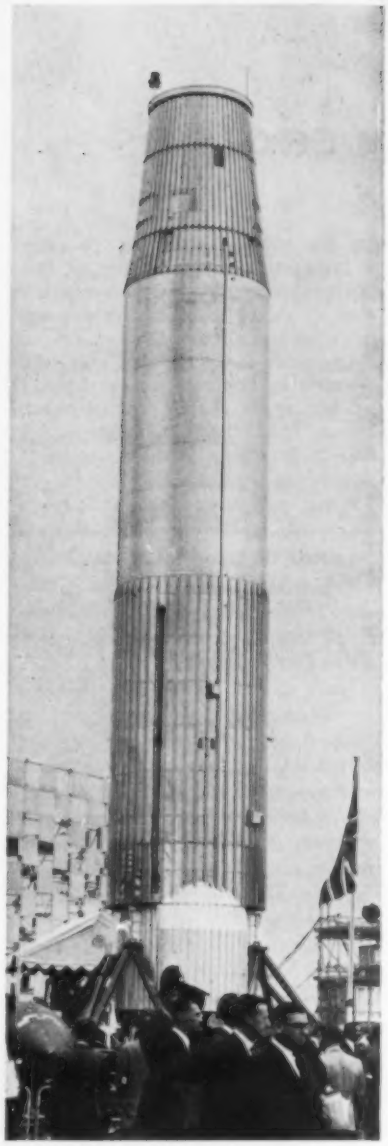
Blue Water is still considered one of Britain's hottest missile export items. It still is the chief contender with the U.S. *Sergeant* for adoption by NATO.

Short Bros. and Harland exhibited the *Seacat* ship-to-air missile. Both Sweden and West Germany have ordered *Seacats* for evaluation; it already has been adopted by Australia and New Zealand.

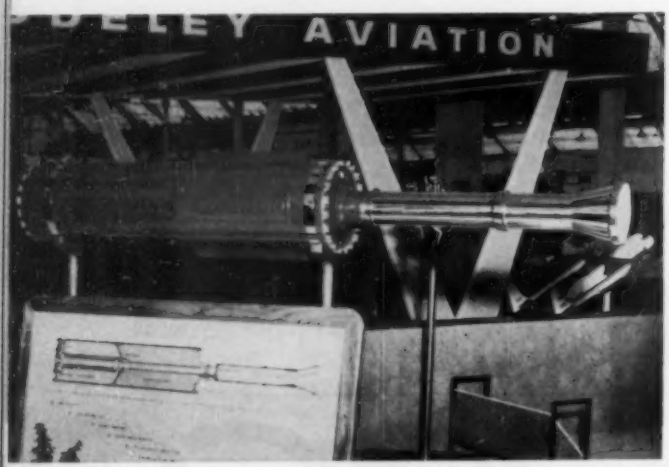
British Aircraft exhibited *Thunderbird* and *Bloodhound* surface-to-air missiles. Hawker Siddeley showed off its *Firestreak*, *Seaslug* and *Blue Steel* stand-off missile. *Red Top*, successor to *Firestreak*, also was displayed.

Among the antitank missiles were the Fairey *Malkara* and the British Aircraft *Vigilant*.

The *Vigilant* is reported to be under consideration by the Indian Army. The British Army has some 400 *Malkaras* on order. ¤



MODEL of the Blue Streak.



DEHAVILLAND Spartan storable liquid rocket engine.

AUSSIES' Malkara was also shown at Farnborough.

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In operation . . .

Army's 'BIRDIE' Air Defense Control

Miniaturized Missile Master built by Martin helps to guard medium-size cities, military bases

by James Trainor

A "VEST-POCKET" air defense system—designed to protect military installations or cities in the 600,000 population class—has been revealed by the Army.

Built for the Army Signal Corps by the Martin Co., the new system—described as a transistorized Missile Master—is already installed and in operation at Turner AFB, near Albany, Ga., and at the Army Air Defense School at Fort Bliss, Tex. It is scheduled for deployment at 17 additional locations in the near future. Location of these is classified until after they are operational.

Nicknamed "BIRDIE," for Battery Integration and Radar Display Equipment, it was shown in Washington last week at the annual meeting of the Association of the United States Army.

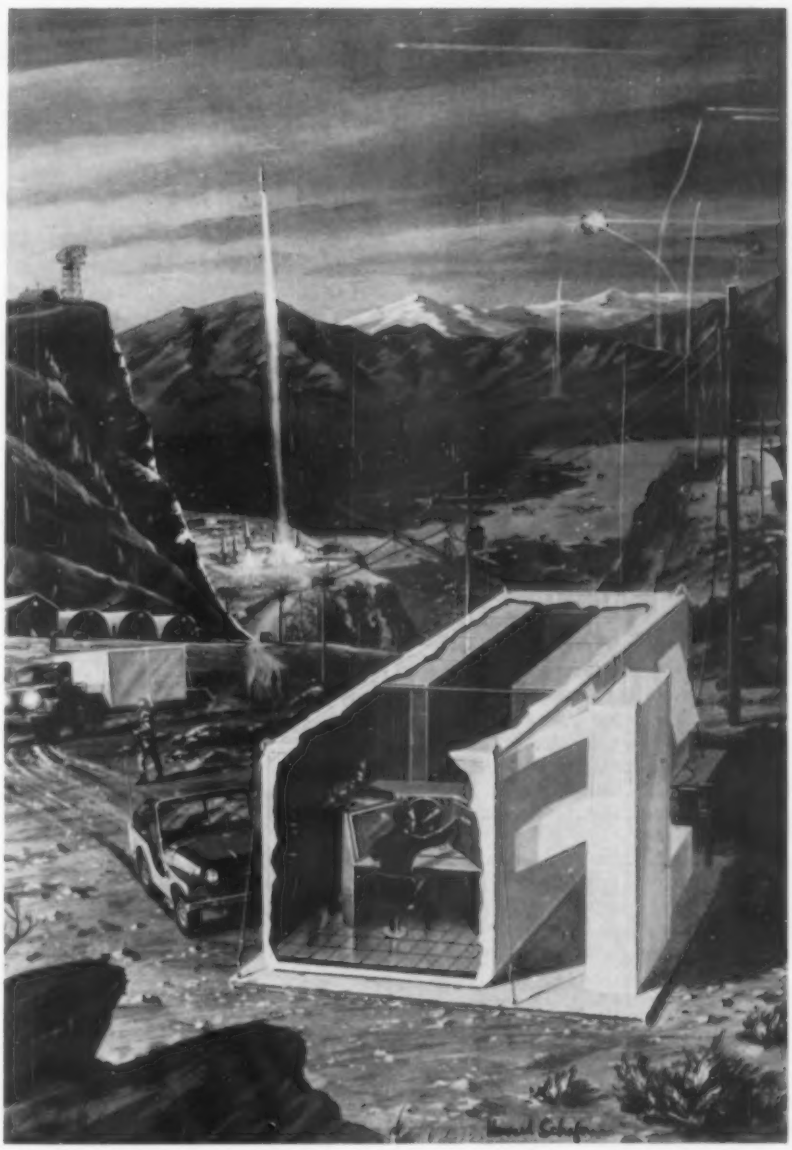
BIRDIE gives the Army a compact, transportable means of processing and distributing information about aircraft to guided missile batteries, and of coordinating the defensive fire of *Nike-Ajax* and *Nike-Hercules* missiles. Its principal advantage is that each of the systems can be tailored to the size of the local defense to which it is assigned at a reasonably low cost per system.

It will be tied by the Army's Air Defense Command (ARADCOM) into other air defense control systems such as NORAD thus integrating local Army defenses with the entire North American air defense complex. However, it can operate autonomously in the event that inputs from higher headquarters are interrupted.

• **Two styles**—BIRDIE uses 97% less space, 95% less power and 80% fewer personnel than its bigger brother, Missile Master. It consists of two types of equipment: the AN/GSG-5(V) and the AN/SG-6.

The former contains a storing and processing facility and track-while-scanning equipment for the continuous

(Continued on page 43)



MARTIN ARTIST'S conception of the U.S. Army BIRDIE air defense coordination system in action, helping to protect a metropolitan area against air attack.

Opportunities for:

Aerospace Vehicles Engineers

The Aerospace Vehicles Laboratory of the Space Systems Division has openings for nearly one hundred engineers who have experience in stress, structures, propulsion, mechanisms, control systems, equipment installation or heat transfer which can be applied to advanced aerospace weapons systems or vehicles. The Aerospace Laboratory is concerned, as a result of SURVEYOR and other contracts, with lunar and space exploration, air to air missiles and ICBM defense systems. The openings are for both junior and senior mechanical engineers, electronic engineers, physicists and aeronautical engineers. Some of the openings are described below:

Structures

Senior Dynamicist. Must be capable of performing advanced analysis in structural mechanics. Will be required to calculate response of complex elastic systems to various dynamic inputs including random excitation. Must be capable of original work in developing advanced analytical techniques.

Loads Analyst. To establish structural design criteria for advanced missiles and spacecraft. Should be capable of determining external airload and inertial force distributions.

Reliability Analyst. To perform statistical analysis of structural loads and strength properties for the purpose of establishing structural reliability criteria on a probability basis.

Stress Analyst. To perform advanced stress analysis of complex and redundant missile and spacecraft structures. Will be required to solve special problems in elasticity, plasticity, short time creep and structural stability.

Design. Experience is required in preliminary and final structural engineering and design, including preliminary stress analysis. A knowledge of the effects of extreme temperature environment and hard vacuum, plus a background in materials is desired.

Heat Transfer

Space Vehicle Heat Transfer. Basic knowledge of radiation conduction and convection heat transfer with application to thermal control of space vehicles is required. Knowledge of spectrally-selective radiation coating, super-insulations and thermal vacuum testing is of particular value.

Aerothermodynamicist. Experience in hypersonic real gas dynamics, heat transfer, abalation; re-entry vehicle design, detection; shock layer, wake and rocket exhaust ionization; and anti-missile system requirements will be most useful.

Equipment Installation

Packaging and Installation Engineer. To perform optimum packaging and installation design for missile and/or spacecraft units, considering amount and geometric shape of space available as well as weight and center of gravity distribution requirements. Must be capable of analyzing structural adequacy of unit under extreme environmental conditions.

Controls

Optical Devices. Design, development, procurement and test operations are involved. Considerable experience in the field of optical devices for space applications such as star, horizon, sun and moon trackers.

System Test. To plan and supervise the operations of a flight control system laboratory. Air bearing tables and a wide variety of optical mechanical and electrical equipment are involved.

Control System Analysis. Requires engineers at various levels of experience including senior men capable of taking over-all project responsibility in the synthesis and analysis of control systems.

Circuit Design and Development. Experience in design and development of transistorized control system circuits, including various types of electronic switching and modulation techniques is required.

If you are a graduate mechanical engineer, electronic engineer, physicist or aeronautical engineer, with experience applicable to the above openings, please airmail your resume to: **Dr. F. P. Adler,** Manager, Space Systems Division, Hughes Aircraft Company, 11940 W. Jefferson Blvd., Culver City 76, California.

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ASTRONAUTICS

Fences in Space?

According to a theory advanced by J. M. Boyer of Northrop's Radioplane Division, the trapped particles in the Van Allen radiation belts are actually caught in fences of long-wave radio signals and bounce back and forth between the fences like ping-pong balls. The current theory that the particles are trapped solely by the earth's magnetic field is inadequate, according to Boyer, because "radio telescopes have shown that space is one vast, unending bedlam of radio signals broadcast in all directions by celestial bodies." Both the trapped particles and the long-wave standing waves, according to this theory, originate in the sun.

ELECTRONICS

Army Receives New Combat Computer

A new general-purpose computer, called the Informer, has been delivered to the Army Signal Corps by IBM. Part of the Army's family of combat area data processers, the system fits into a 2½-ton truck and is designed for all-weather, all-terrain operation. Informer—for use with division, corps or army elements—can be adapted to missile checkout, logistical problems, intelligence data storage and retrieval, damage assessment and map compilation.

Inertial Data System Guides X-15

An inertial flight data system—developed by Sperry Gyroscope Co.—has been used to guide the *X-15* from launch through the hypersonic acceleration phase of the flight to controlled re-entry into the earth's atmosphere. Heart of the system is a three-gyro stable platform, incorporating advanced miniaturization of the electronic components and all its own power supplies and amplifiers. A lightweight computer digests and interprets this data and displays it pictorially for the pilot on specially-developed cockpit instruments.

Computer Utilized for Saturn Pre-flight Tests

An RCA ground checkout computer system is being utilized at NASA's Marshall Center to develop automation techniques to insure higher vehicle reliability. It will decrease the time necessary for pre-flight checkout of the *Saturn* and other large multi-engine vehicles. The computer provides a real-time basis for monitoring and controlling *Saturn* tests, and provides both magnetic core and drum memories for storing the main program, processed data and emergency programs.

Step-and-Repeat Photography Wins Favor

To facilitate rapid, accurate production of micro-miniaturized components for electronic circuitry, many firms are turning to step-and-repeat photography. This method—used to achieve multiple identical images from a single piece of original artwork—photographically reduces the complete pattern and then automatically steps up on the Misomex at the rate of 350 exposures per minute, to an accuracy of .001 inches over the entire exposure area. Repeating the process will achieve even further miniaturization.

SUPPORT EQUIPMENT

PACM Telemetry Under Study

Air Force is investing about $⅓ million in the study of potential PACM telemetering systems in spite of an industry consensus that the approach recommended by Aeronutronic won't prove practical. WADD feels that the combination pulse amplitude/pulse code technique does hold promise—and must be more fully explored before its feasibility can be decided. Most telemetering experts agree on the potential of PACM, but disagree on the approach.

Mobile Tracking Mount Under Development

An automatic tracking mount—scheduled for operation in 1962—is being developed for the Navy by American Machine and Foundry Co. The mount will provide missile-tracking cameras with a greater degree of movement in elevation and azimuth, increasing accuracy and broadening photo coverage.

ASW & SEABORNE ENGINEERING

Bendix Gets Polaris Controls Award

Five automatic maneuvering control systems for *Polaris* submarines will be built for the Navy by Bendix's North Hollywood, Calif., Div. The system controls the submarine's steering and diving mechanism through a solid-state computer which receives signals from the speed, course and depth instruments. The computer in turn regulates electro-hydraulic valves in the steering, diving and fairwater planes.

Marines Plan Amphibious Hydrofoil

A new type of amphibious support vehicle—able to "fly" across the water on hydrofoils and travel on land as a wheel vehicle—is being built by FMC Corp. for the Marine Corps. The versatile vessel will have retractable foils and wheels which will enable it to cut through the water at speeds in excess of 35 knots and travel on land at speeds of more than 25 mph. The craft—designated the LVHX2—will be used by the Marines to swiftly transport troops and equipment from ship to shore and then across country during the support phase of an amphibious operation.

ADVANCED MATERIALS

Bendix Gets Tape Controls Contract

The 11 numerically controlled profiling machines being purchased by Douglas under the Air Force Machine Tool Modernization Program will be equipped with $750,000 worth of controls from Bendix Corp.'s Industrial Controls Section. Giddings and Lewis, and Sundstrand will provide the machine tools.

Recovery System Passes First Test

Goodyear's Ballute inflatable drag device, successfully recovered a 500-lb. test missile from 100,000-ft. altitude. The Air Force program will ultimately test the balloon's ability to recover missile equipment at Mach 10. In the current phase, the ballute was released at 88,000 ft. and final stages of the descent were under parachute.

advanced materials

GE Geared to Build Huge Solid Cases

Company says it has tools at Schenectady for 20-ft.-dia. case fabrication; Minuteman team at Evendale could serve in larger program

by John F. Judge

CINCINNATI — General Electric is moving swiftly into the highly competitive large-solid-rocket motor case market—right up to 240-in.-diameter chambers.

R. H. Wettach, Jr., Manager, Solid Rocket Cases, says the firm already has functioning in its Schenectady generator shops most of the massive tooling necessary to fabricate the huge pressure vessels.

That facility has roll and weld capabilities, boring units handling up to 42-ft.-diameter pieces, and vertical lathes which easily work 16- and 24-ft.-diameter sections 12 to 14 feet high under the rail.

"Schenectady is essentially facilitized to handle a 160-in. case and 240-inch jobs wouldn't strain them a bit," says Wettach. Transportation problems are minimized by the department's location and past experience with large, heavy and delicate products.

There are many problems—the main one being adequate heat-treating furnaces. But the technology is new, and the first chambers will be largely R&D items. GE spokesmen are positive that solutions will be found without hampering operations to any great extent.

• **Case craftsmen**—GE's ace in the hole is the highly experienced team currently producing *Minuteman* first-stage motor cases at the Evendale, Ohio, plant. This core of experts, proficient in the exacting detail work essential to the manufacture of large motor cases, could form the nucleus of the bigger Schenectady operation.

Apart from the *Nova* concept, Wettach says the Evendale plant can fabricate and heat-treat 100- and 120-in. cases. The new gantry heat-treat furnace is already strengthening 120-in. experimental cases from Excelco Development, destined for Grand Central Rocket Co.'s large booster programs.

In all probability, the 100-in. cases will originally be roll-and-welded, but Wettach feels roll forming will eventually take over because of the extreme advantage in eliminating the longitudinal seam.

For the 100-in. job, the case men are eyeing the AEC-owned equipment left from the ill-fated ANP program. Large vertical lathes and boring mills, bought for the nuclear plane project, stand idle at the other end of the huge GE Evendale facility and could very easily fit into a large case-fabricating process.

• **Components subcontracted** — In the *Minuteman* case production, GE farms out a great deal of the component machining. The forward head, center sections, aft head and closure are all machined by vendors and delivered to GE.

LEFT: *Massive solid booster cases could be fabricated on the large vertical machine tools currently producing electrical gear at GE's Schenectady works.*

The machined cylindrical preforms for the center of the case are roll-formed on a Cincinnati 75-x-100-in. Hydrospin. The working rolls have a travel of 104 in. and a horizontal movement of 42 in. The unit can finish a cylinder 78 in. across and 100 in. long. The tail stock will move 104 in. vertically, but also sideways to form cylinders 200 to 300 in. long. GE is not now forming complete center sections in the *Minuteman* program, but the machine has that capability. The cylinders are stress-relieved after machining. If two passes are necessary, this operation is performed twice.

Welding processes are carried out on a large Lewis machine with a Sciaky electro-welding head. Welding is automatic, but an operator can override the controls if something goes wrong.

The case, except for the aft closure, is then heat-treated in the huge 120-in. furnace GE constructed specifically for motor cases. The circular system includes a gantry-type furnace and seven pits. The furnace, with a 1030-kw power rating, can raise an 8000-lb. load of steel from 1000° to 1500°F in an hour. The unit can be set to any temperature up to 2000° with ±10°F accuracy.

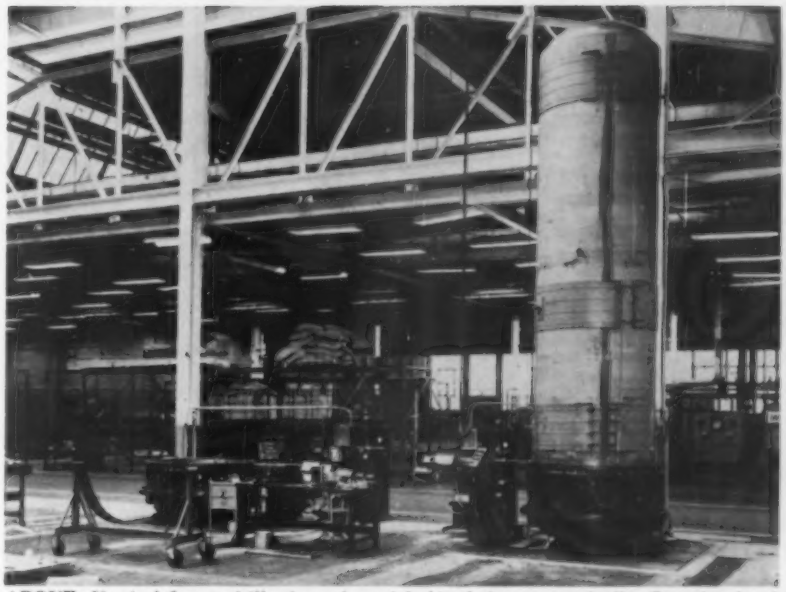
In the pits, there are two furnaces for combination preheat, tempering and stress relieving operations, one salt-quench station, one still-air quench station, one combination water-quench and rinsing station and two additional pits for future oil-quench.

The furnace has a controlled atmosphere—currently Thermalene gas. The pit furnaces can also incorporate controlled atmosphere operations. In case-treating the quenching rate must be carefully controlled to avoid out-of-roundness. Each case is measured for this defect after high heat and then fully fixtured stress-relieved.

Again the case is checked for roundness.

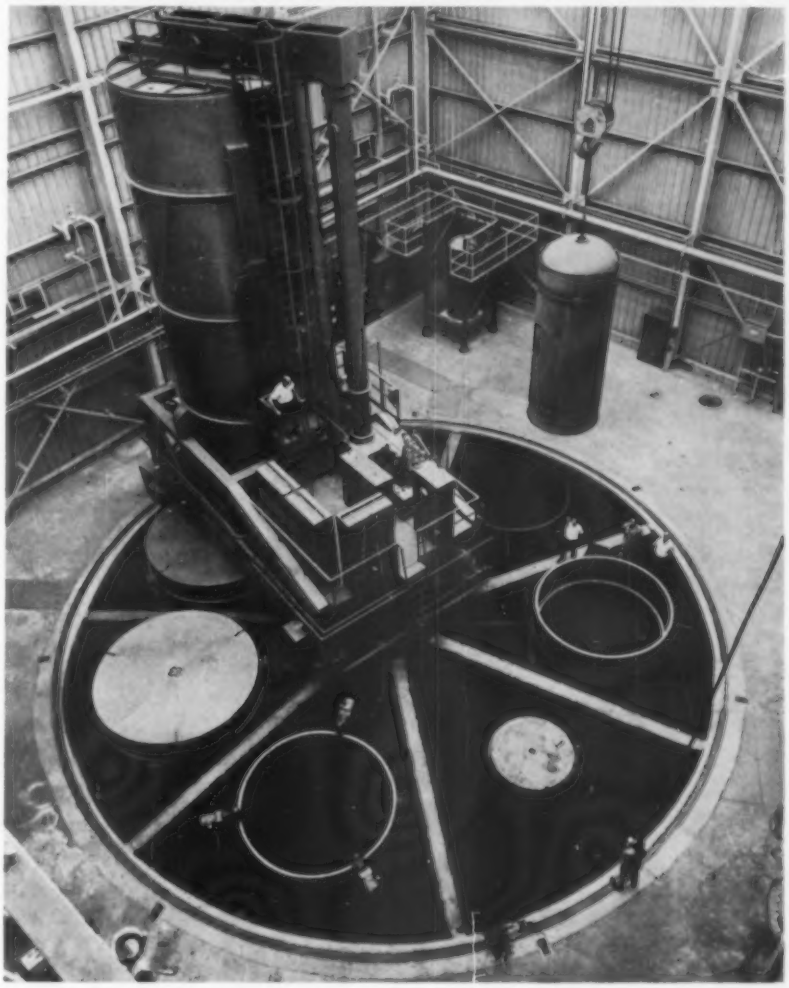
• **Machining hardened cases**—The threading operation takes place after the heat-treat when the case and aft closure is in the hard condition. This GE innovation is spreading to other manufacturers. All finish-machining on the case is performed in the Merz thread-machine fixture. This excludes one drilling operation.

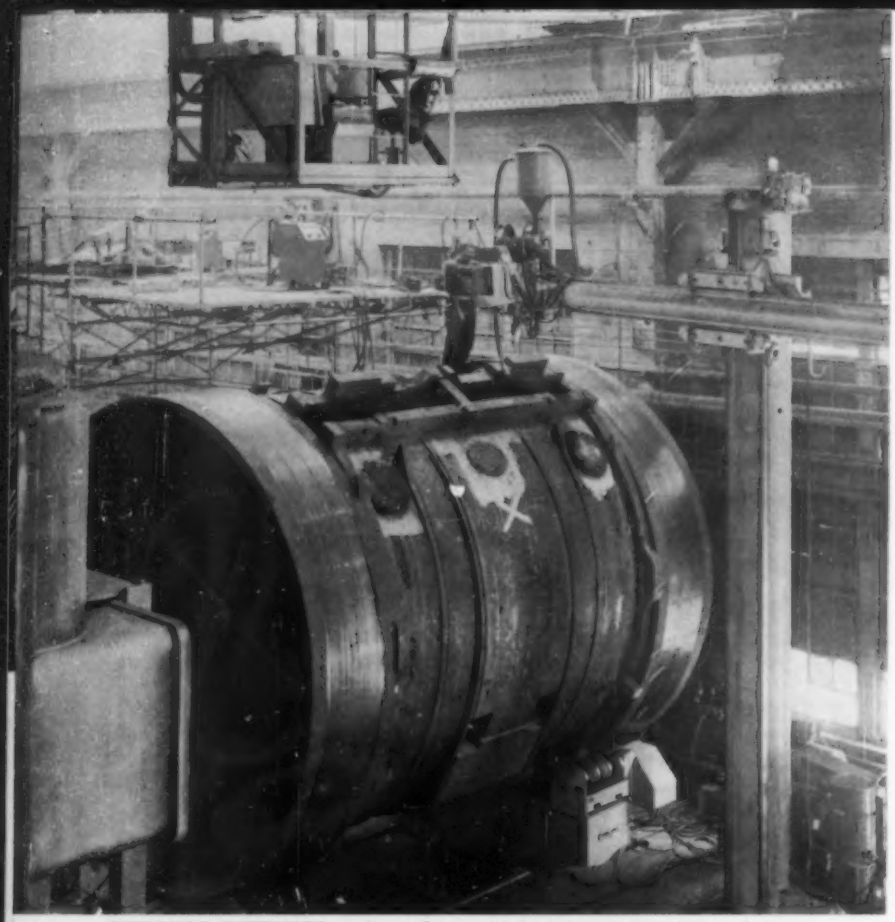
The aft closure is buried in epoxy on its fixture for threading and facing. The piece is then mated to the case. GE is purchasing a new machine from Merz to increase capacity. At the same time, the unit is being uprated to allow only one fixture for the aft closure.



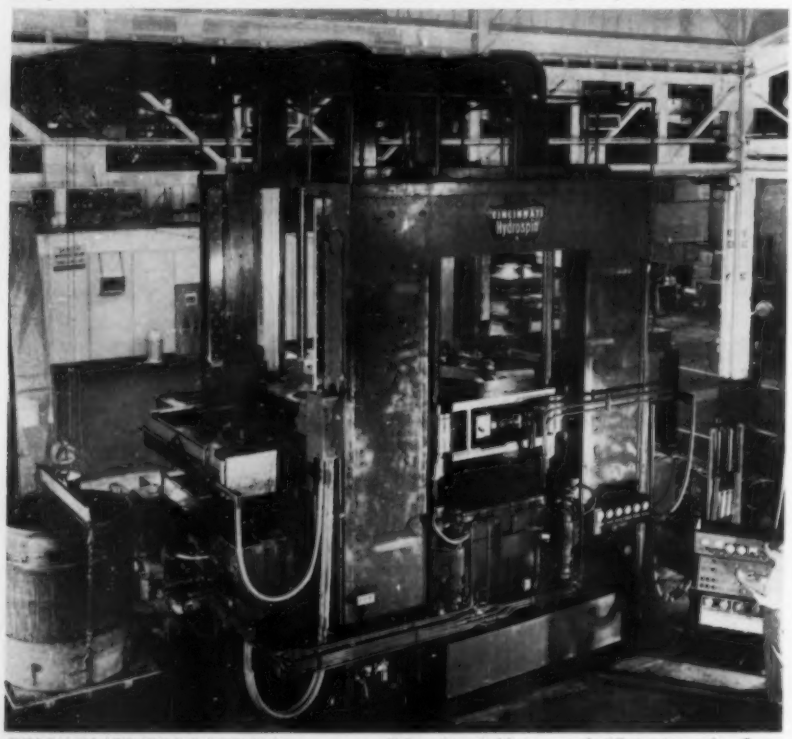
ABOVE: *Vertical fixture drills circumferential skirt holes automatically. Completed unit is Magnafluxed and X-rayed, then hydrotested with oil.*

BELOW: *Huge heat-treating furnace built by GE specifically for motor cases is currently strengthening the 120-in. Grand Central Rocket chamber.*





WELDING FIXTURES such as this could be adapted to joining of pressure-vessel components without the tremendous expense involved in completely new facilities.



CINCINNATI HYDROSPIN has an overall height of 38 ft., sunk 17 ft. into the floor. The unit can roll-form a complete Minuteman case center section.

GE drills the skirt holes with the case in a vertical position. The completed unit is Magnafluxed and X-rayed, then hydrotested with oil. A second final inspection takes place and the chamber is shipped to Thiokol Chemical Corp., propulsion prime contractor for first-stage *Minuteman*.

While the machines and tooling in the *Minuteman* case program at GE are impressive, the key to operationally perfect chambers lies in the manufacturing personnel and the extreme care taken with each step. In the welding operation alone, the operator has a multi-page check list which requires him to perform over 60 different tasks—some of which are not connected with the actual welding operation.

Wettach says the basic theme is to take a standard operation and carry it to the ultimate degree of perfection. In the welding sequence, some of the requisite actions include vacuum cleaning the floor area, shutting down certain air-circulating equipment and additional drying of the welding gas. Odd little things, like finding it better to eliminate the grinding wheel in weld preparation and using only carbide burr tooling, have been picked up along the way.

Even the welding stock is hermetically sealed and opened just prior to use. Excess after one operation is not used in the next. The stock is carefully kept clean—even a fingerprint could result in a defective weld.

The same procedure led GE to perfect a method of tapping a closed hole in Rockwell 52 steel—a task termed "impossible" but accomplished with standard equipment by exact control over every conceivable variable.

• **Tight little island**—Another striking transition from traditional manufacturing is the foreman setup in the rocket-case section. The men performing the actual work are under close supervision by graduate engineers fulfilling all the tasks normally handled by foremen. These engineers are chosen for technical competence and ability to work with the men on the floor.

This tight organization is extremely responsive to management and they, in turn, have learned to respond quickly to customer needs.

Wettach says the missile case business is much more competitive than the jet engine market. He has found elaborate "sell" methods uneconomical. The small group of customers buy on quality, reliability and price. The last item is becoming more and more important as the technology and competition improves. GE is working PERT into its case operations and much of its proposed large chamber work will be keyed to this management system. ⁂

Soviet Efforts Are Closely Watched

by William Beller

SOVIET PHYSICISTS are vigorously pushing gravity research—and publicly lamenting their "uncertainty and frustration."

Any advance in understanding gravity—long overdue compared with recent breakthroughs in other branches of physics, such as subatomic physics and field theory—could give enormous advantages to its discoverers.

Consequently, the Soviet work warrants the "closest continued watchfulness."

These are the chief findings handed to the Air Force's Aerospace Technical Intelligence Center—now the Foreign Technical Division—by the Library of Congress' Science and Technology Section last October. The study was made by Garbell Research Foundation of San Francisco. Intelligence sources say that the picture is still the same today.

The study of Soviet hypotheses and reports on gravitation indicates that all serious scientific thinking published in the Soviet Union is rooted in the fundamental theories developed in the West. Einstein's theory is characterized as "the best existing theory," or at least as "the predominant theory" of gravitation.

During the 1957 winter and the following spring, Dr. Kirill P. Stanyukovich, mathematics professor at the Moscow Higher Technical School spoke of "forthcoming advances" in Soviet ability to overcome the pull of gravity on aircraft and space vehicles. These predictions by a leading Soviet scientist admittedly sparked the Air Force-sponsored study.

• **Mass without weight**—If statements about gravity had been made by a lesser light than Stanyukovich, they probably would have been ignored by our military. However, Stanyukovich is a member of the Interplanetary Flight Commission of the Soviet Academy of Sciences, a top-ranking scientific and policy-making organization. Moreover, he is widely recognized as a brilliant mathematician and physicist, and a specialist in gas dynamics and fluid dynamics.

Some of his work—whose publication has been sponsored by Academician N. N. Bogolyubov, the eminent Stalin-prize-winning mathematician and physicist—has appeared in the Academy's journal. Furthermore, Stanyukovich has co-authored several important scientific papers with Academician I. D. Landau, another internationally-known Soviet physicist.

Here's the essence of some of Stanyukovich's recent remarks about gravity:

—He broaches the possibility of a "graviplane," a machine not subject to gravitational forces.

—He theorizes that "lowering the temperature of matter to absolute zero would lead to a considerable decrease in gravitational forces and possibly their disappearance," thereby creating "weightless matter."

—He envisions "weightless matter" being used to build aircraft and space vehicles.

—He has constructed a theory in which the gravitational field of ponderable masses is caused by superhigh-frequency (multi-billion-cps) vibrations of matter and by the ejection—from the vibrating body—of energy in the form of gravitational quanta or "gravitons." Stanyukovich states that this gravitational radiation "would be more intense at high temperatures and, conversely, reduced virtually to zero at low temperatures, near absolute zero.

—He predicts the use of antimatter (matter made up of antiprotons and positrons instead of protons and electrons as in ordinary matter) to overcome gravitation.

• **There are disbelievers**—These are all observations that can readily find their duplicate in science-fiction writings. Yet they were enunciated by a respected scientist and investigated by a U.S. intelligence agency.

The study made for the Air Force points out that "Although authoritative Soviet physicists delineate the current status of Soviet research on gravitation with a measure of uncertainty and frustration, their efforts, like those of their Western colleagues, are so intense and unflagging that they warrant the closest continued watchfulness."

Stanyukovich's assertions are receiving no public support from his colleagues, and are scorned by at least one renowned Soviet physicist, D. D. Ivanenko.

Soviet-area physicists have proposed widely different theories on gravitation, and the Air Force intelligence report narrows them down to the following three:

Some scientists, such as L. Infeld (Poland), regard gravitation as a purely geometric phenomenon which does not comprise any radiational transfer of energy between bodies; hence, there is nothing in the gravitation field that man can modify.

Other scientists, such as V. A. Fok and D. D. Ivanenko (USSR), believe there are energy-carrying "gravitational waves" which can be quantized into energy quanta, hypothetically named "gravitons." However, these men consider the amount of energy transported to be so small as to be a wholly negligible aspect of gravitation. Thus, even a total elimination of gravitational-wave quanta or "graviton transmutation" could not effect an annihilation of gravitation.

There are also Stanyukovich's views, with which he stands almost alone, at least publicly.

• **Feet of clay**—The gravitational force, which is the oldest known to man and the first one theoretically distinguished, still suffers observationally. In fact, over the past half century there has been practically no fundamental work done on gravitation.

In addition, aside from the theoretical papers by Einstein and his associates, "there is no single major theory or scientific hypothesis on gravitation on which agreement of a substantial majority of theoretical physicists can be found," according to the Air Force report.

The study also sadly relates that "The prevailing disagreements appear indelible and unyielding, so long as no experimental proof can be adduced to establish at least some points of common acceptance."

(This 389-page study has recently been released through the Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C. It costs $5.)

Whatever the reason for the lag in experimental gravitational work, Princeton University physicist R. H. Dicke says it "has resulted in one of the most beautiful theoretical edifices of physics resting upon a very weak observational foundation." ¤

Practical Anti-Gravity Still Far Off

Theoretically feasible ways to counteract earth's pull abound, but machines require new materials and advanced theories

by Robert L. Forward

THERE'S LITTLE TROUBLE predicting anti-gravity from Einstein's theory of gravity. Nor is it a problem to conceive anti-gravity devices, at least in theory.

But, unless there are major breakthroughs in both theories and materials, a practical anti-gravity device is a long way from realization.

There are many well-known solutions to Einstein's theory of gravity which show that the gravitational force exerted by a body depends not only upon the mass of the body but also on its motion.

Because of these gravitational effects due to rotating or accelerated masses, it is possible, in theory, to construct a device that will create a gravitational field in any direction. By generating this field in an upward direction at some spot on the earth, we could theoretically counteract the earth's gravitational field.

Unfortunately, the calculated effects are very small if we assume presently available materials and energies. Unless a major breakthrough is made along these lines, it is probable that practical anti-gravity will be technologically impossible for a long time.

Einstein's theory—All of the advanced research into gravitation has been in theoretical studies using Einstein's General Theory of Relativity. The very compact and logical structure of Einstein's theory suggests that there is no mathematical difference between the effect of a gravitational field and the effect of a curved space.

From this point of view, static and moving masses do not create gravitational fields but instead cause the space around them to be curved. Then instead of having bodies moving under the influence of gravitational forces in a flat space, we have bodies with no gravitational forces on them moving in a curved space.

This concept has a great deal in its favor because the mathematical equations and logic are immediately simplified by many orders. However, this

GRAVITY GLOSSARY—*Below is a list of key terms involved in discussions of gravity, with their definitions.*

GENERAL RELATIVITY A theory of gravitation. Presently accepted as the best theory of gravity, but there are only a few experimental verifications. Distinct from SPECIAL RELATIVITY.

SPECIAL RELATIVITY—A theory of velocities. Used every day in atomic research. Distinct from GENERAL RELATIVITY.

ACTIVE GRAVITATIONAL MASS—That property of a body which gives rise to a gravitational field. Probably identical with PASSIVE GRAVITATIONAL MASS and INERTIAL MASS.

PASSIVE GRAVITATIONAL MASS—That property of a body which is affected by an applied gravitational field. Probably identical with ACTIVE GRAVITATIONAL MASS and INERTIAL MASS.

INERTIAL MASS—That property of a body which determines the resulting acceleration for a given force. Probably identical with ACTIVE and PASSIVE GRAVITATIONAL MASS.

ANTI-GRAVITY—A confusing term since there are at least five different ways conceivable to counteract gravitational fields. (See LEVITATION, SHIELDING, NEGATIVE MASS, GRAVITY GENERATION, NULLIFICATION.)

LEVITATION—The PASSIVE GRAVITATIONAL MASS of some object is transformed so that gravitational fields do not affect it—e.g., magic carpet.

SHIELDING—A material which would intercept gravitational fields, creating a field free region. AC gravitational fields can be shielded against by a mass with an infinitely strong acoustic resonance at the field frequency. To shield against DC gravitational fields would require mass dipoles or NEGATIVE MASS.

NEGATIVE MASS—A material with a negative ACTIVE GRAVITATIONAL MASS which could be used to repel ordinary matter. There is strong evidence that ANTI-MATTER does *not* have negative mass.

GRAVITY GENERATION—The generation of gravitational fields by means other than a static mass. Einstein's GENERAL RELATIVITY predicts that moving masses generate GRAVITATION-LIKE FORCES which are distinct from the forces due to the usual static NEWTONIAN GRAVITATIONAL FIELD. (See also PROTATIONAL FIELD)

NULLIFICATION—The ability to control the ACTIVE GRAVITATIONAL MASS of a body or the gravitational constant so that the gravitational field of the earth could just be "turned off."

GRAVITATIONAL WAVES—Time-varying waves of gravitational energy, quite similar to electromagnetic waves. Einstein's GENERAL RELATIVITY equations for gravitation reduce to a wave equation with velocity c when linearized.

DWARF STARS—Dying, collapsed stars with densities about 10^{10} gm/cc. They average about one in 100 stars. Such super-dense material would be valuable for gravitational experimentation.

ANTI-MATTER—Matter made from positrons, anti-protons and anti-neutrons, which have an opposite charge and magnetic field from their "normal" counterparts. Anti-particles and normal particles are formed in pairs from gamma rays. From the EOTVOS EXPERIMENTS it is known that positrons have identical INERTIAL MASS and PASSIVE GRAVITATIONAL MASS.

EÖTVÖS EXPERIMENTS — Experiments which showed that INERTIAL MASS and PASSIVE GRAVITATIONAL

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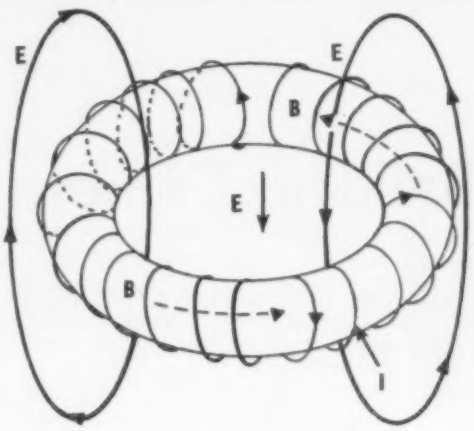

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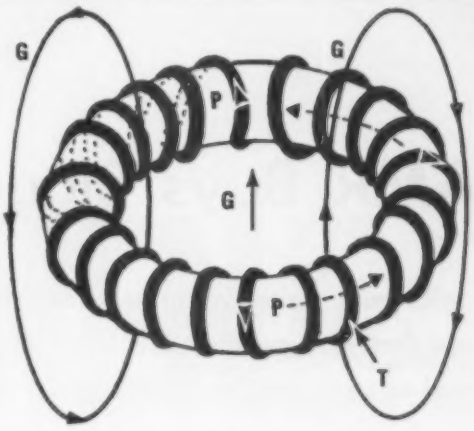

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1B

formalism—which combines gravitation, space and time into one compact and logically simple form—has the unfortunate property of completely obscuring things from a practical point of view.

There is another formalism in which Einstein's theory may be presented—one which, in many ways closely corresponds to the formalism of electromagnetic theory. For every field and force in electromagnetic theory, there is a corresponding gravitation field and force. In addition, there are other gravitational effects which have no counterpart in electromagnetic theory.

For instance, the one analogy that we all know about is that the gravitational field of a static mass corresponds to the electric field of a static charge. The equations are the same and the only differences are that two particles with the same type of charge repel, whereas two particles with the same type of mass attract.

• **A new gravitational field**—Besides this well-known analogy, there also exists a gravitational equivalent to the magnetic field. This field arises from the effects of moving or rotating masses. It obeys the same form of equations as the magnetic field; all the things that can be done with a magnetic field can be done in an analogous manner with this field.

For instance, if a massive particle moves through this gravitational equivalent to the magnetic field, then it experiences a gravitation-like force; but the force on the particle is at right angles to both its direction of motion and the direction of the field.

By a gravitation-like force, we mean that the accelerations given to the test body by this force are independent of the mass of the test body, and therefore are indistinguishable from gravity. Because gravitation-like forces act independently on each atom of the body at the same time and with the same acceleration, there are no internal stresses in the body and very large accelerations can be tolerated.

It is because of this possibility of using very high accelerations in space vehicles without any stresses being exerted on the occupants that makes gravitational methods of propulsion very attractive.

Other conceivable effects of this field include the following: Two pipes with a massive liquid flowing rapidly through them will repel each other due to the gravitational equivalent of the "pinch effect," and two massive rotating gyroscopes will repel each other if properly oriented. None of these predicted effects have been seen and when we put numbers into the equations, we can see why—the effects are very small if we use presently available material and energy sources.

• **Anti-Gravity** — It is also, in theory, possible to build a machine to create a field that will exert a gravitation-like force in any direction, on any ordinary, non-rotating, non-moving mass such as a person. Thus, by generating this field in an upward direction at some spot on the earth, we could theoretically counteract the earth's gravitational field.

These and other non-Newtonian gravitational forces have been calculated for a number of specific models; equations describing these forces are available in texts such as C. Moller, *The Theory of Relativity*, page 319, and J. Weber, *General Relativity and Gravitation Waves*, page 160. The calculated effects are very small.

An example of such an anti-gravity machine, readily visualized by its analogy to electromagnetism, is a system of accelerated masses whose flow can be approximated by the current flow in a wire-wound torus or ring.

(Continued on page 45)

MASS are identical to 1 part in 10^8 for all substances tested. Indirectly this also shows that the two masses are the same to 1 part in 10^5 for energy such as gamma rays and 1 part in 10^2 for positrons. (See ANTI-MATTER)

NEWTONIAN GRAVITATIONAL FIELD—A field generated by all bodies whose strength is proportional to the ACTIVE GRAVITATIONAL MASS (M_a) of the body. The field will exert a force on other bodies whose strength is proportional to the PASSIVE GRAVITATIONAL MASS (m_p) of the affected body. The force will cause an acceleration (a) of the affected body inversely proportional to the INERTIAL MASS (m_i) of the affected body.

$$m_i a = -\frac{GM_a m_p}{r^2}$$

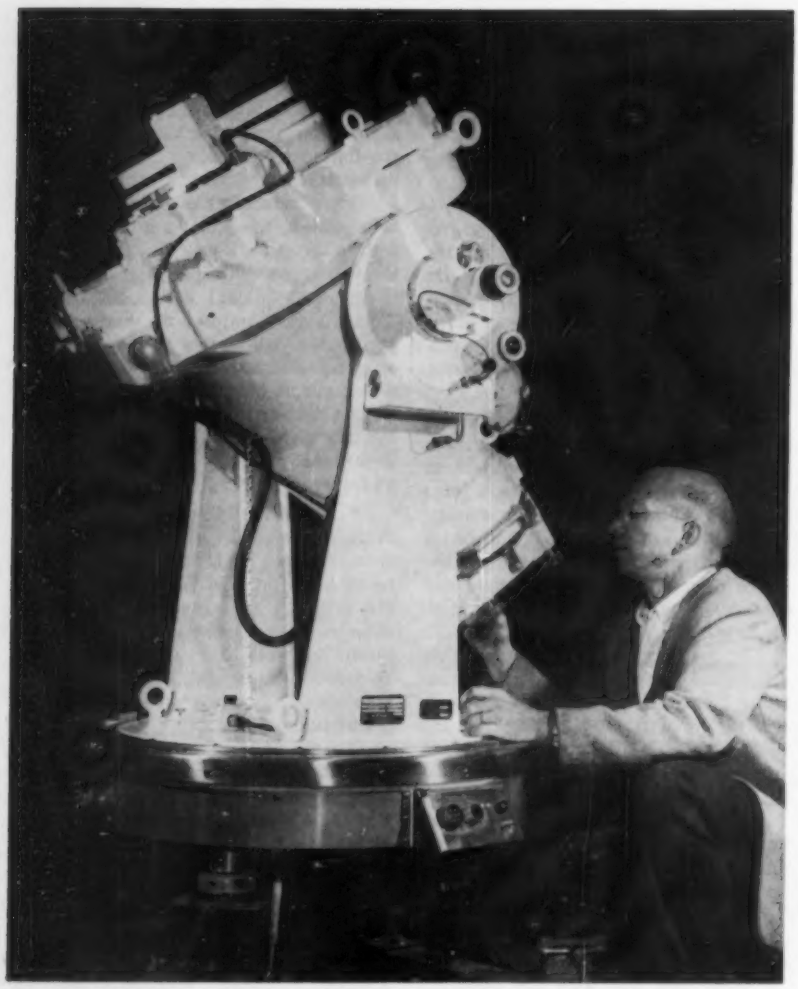
There is strong experimental evidence that there is no difference between the three possible types of mass (See EOTVOS EXPERIMENTS)

GRAVITATIONAL FORCE—A force exerted on the volume of a body which results in an acceleration independent of the INERTIAL MASS of the body, and is therefore indistinguishable from gravity in a local region.

AMR Buys Biggest Ballistic Camera

Nortronics-built units, weighing 1660 lbs. and four feet tall, are first of type ever produced in America and are expected to spot missiles within 26 ft. at 1000 miles

by Charles D. LaFond



1660-LB. BALLISTIC CAMERA, developed by Nortronics for the Air Force, is one of six to be in operation soon on Atlantic Missile Range. The 600-mm F/2.0 system will be used to determine trajectories with accuracy of 1 part in 200,000.

ANAHEIM, CALIF.—The world's biggest known ballistic camera soon will be put to work at the Atlantic Missile Range.

Designed as the penultimate in accuracy for gathering optical data during missile flight tests, the nearly 1700-pound camera is believed capable of linear and angular accuracies to 1 part in 200,000.

Built here by Nortronics Division of Northrop Corp. for the Air Force, the 600 mm F/2.0 ballistic camera is expected to be able to locate a missile within 26 ft. at a distance of 1000 miles, developers say.

First tests, using star images only, will begin this month. Following acceptance, one will be installed at a site in Vero Beach, Fla. The other five will be located on islands downrange; specific sites have not yet been announced.

Contract value to date for development and delivery of the six ballistic cameras is $1 million.

First of its type ever built in the U.S., the camera has many unique design features, including an ultrafast louvre-type shutter assembly for a 12-in. camera aperture. Its 240-lb. lens configuration required development of a new lens-mounting technique to minimize strain within each of the eight oversize optical elements—the largest being nearly 15 in. in diameter.

• **Star background**—The 4-ft.-high ballistic cameras will be installed at several sites throughout the AMR to augment a network of 300 mm aerial mapping cameras now used to record missile flights. The sites, currently employing the Wild Heerbrugg, Ltd., BC-4 ballistic camera, are being modified for installation of the new system.

The ballistic camera is used to determine nearly exact missile trajectory by photographing its flight against a star background. Before launch, the star field is photographed. During the flight, the camera records images of precisely timed strobe-light flashes. Then another star trace is obtained.

Image location of the strobe light is later compared with the star images whose positions are very accurately known to determine angular position of the missile. Multiple-site triangulation techniques are employed to find

missile height with respect to time.

Nortronics designers believe that with proper geometry, linear measurement can be made as accurate as angular measurement.

Under the present contract, six cameras will be delivered to AMTC in Florida. Besides their use in determining missile trajectories, the cameras will be used to obtain position data on orbiting satellites. Because of their unusual accuracy, units will be employed in calibrating electronic tracking instruments and for conducting geodetic surveys.

• **Easily synchronized** — The Nortronics-designed camera is a 1660-lb. fixed instrument having a very fast, almost distortion free, lens system of 600 mm focal length. The shutter assembly is solenoid actuated with open and close pulses generated externally. The iris is electrically controlled remotely and the diaphragm is driven by an integral motor.

Overall design of the system permits installation in almost any location from hardened missile sites to ships. Size and weight of the camera's cast-iron mount provide good static stability and a remote electrical control assists dynamic stability. Excluding the mount, the camera measures 43 in. long and over 29 in. diameter.

The camera is manually oriented; fine adjustments are made through worm gears. It can be locked firmly into position in each axis by clamps. The mount can be leveled to 5 sec. of arc.

Scales on the camera mount for azimuth and elevation location are graduated to 30 sec. of arc. For alignment, an 8-power sighting telescope having an 8 degree field is used. The scope is attached to the upper (elevation) trunnion of the mount.

Azimuth range is a full 360 degrees; elevation from −3 to +95 degrees.

Camera back design follows that of the Wild BC-4. It will accept and use the same plate holder used in the BC-4. The plate holder can be removed easily with the camera in any position.

The shutter pulsing permits use of several cameras for exact sequential exposure along a ballistic path. Cameras can be synchronized easily, developers say, to within 1 millisecond.

Operating cycles can be varied from 10 milliseconds to 2 seconds for synchronized operation.

The shutter opens or closes in 2 milliseconds and it can be programmed to remain open for any length of time.

• **Computer-designed lenses** — A Bendix G-15D computer with plotter attachments was used extensively by Nortronics optical specialists in designing the camera lens system. Through

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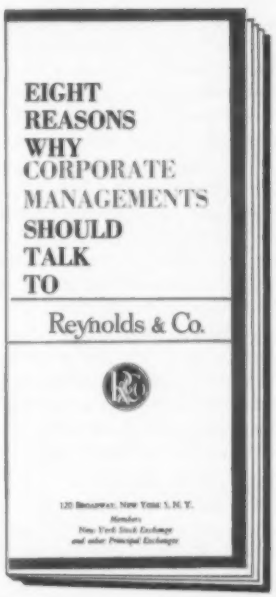

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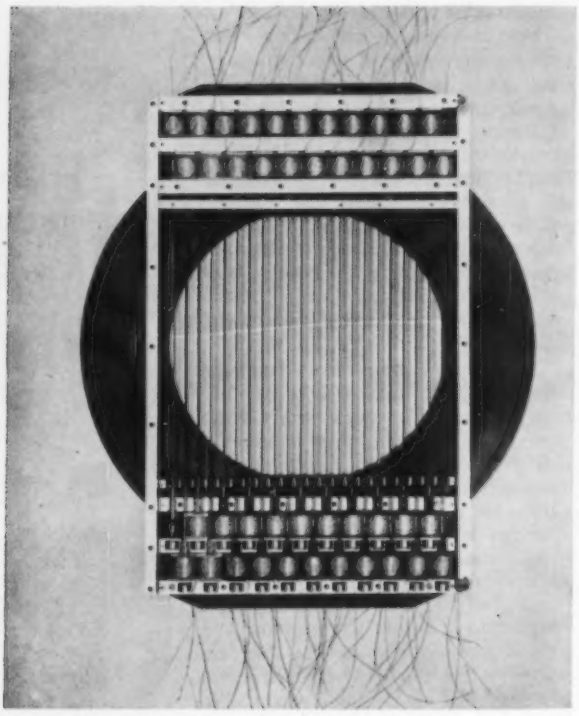
LOUVRE-TYPE shutter assembly is solenoid-actuated. A between-the-lens type, it is located between the second and third elements of the lens system. This is a front view, blades open.



ARMCO STEEL shaft on each of 22 blades of shutter assembly serves as core of actuating solenoids. Pinned cores ride in cam-slot of solenoid spools to turn blades 90 degrees.

its use, said one scientist, the total design period was greatly reduced.

For example, it was capable of tracing a light ray through a single surface in less than 2 seconds. Thus, spherical aberration of the system could be determined in well under 1 minute.

After computation, computer and plotter were used for automatically making spot diagrams at a rate of 100 spots per minute. The plotter also was employed for rapid sketching of the optical system. This, he said, was extremely useful in checking center thicknesses, diameters and clearance.

In the original lens system design, nine elements were to be employed. Later, one element was eliminated when the computer showed the change would have no degrading effect on either quality or performance of the camera.

• **Special glass needed**—To obtain the required refractive index and dispersion characteristics, it was necessary to use a special rare-earth glass for elements 1 and 2 in the lens system.

All lens blanks for the system are being manufactured by Hayward Scientific Glass Corp. The rare-earth elements, according to the company, are the largest such blanks ever cast. Designated RE-10, these front elements are made from lanthanum oxide.

To minimize formation of gas bubbles in the blanks, the elements were cast in crucibles fitted with a platinum liner.

Elements 4, 6, 7 and 8 are of dense barium crown glass. Element 3 is extra-dense flint; element 5 is a dense flint.

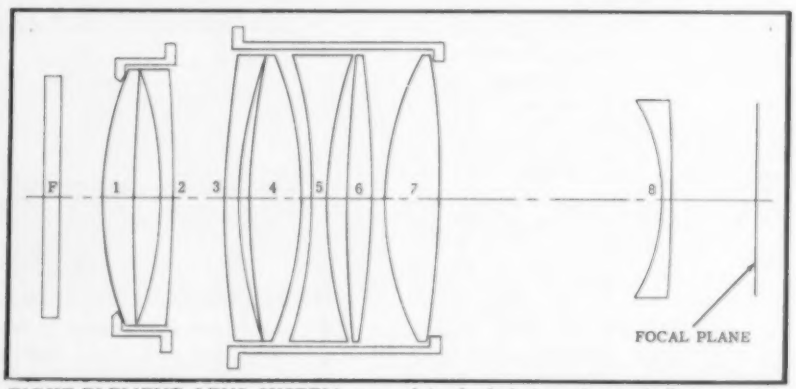
Because of the great size of all elements and the impossibility of maintaining tight index-of-refraction tolerances, final design of each of the other six lenses was determined only after receiving blanks for all eight elements and analyzing their optical properties.

With time, Nortronics developers believe, the front two elements might eventually be made from more conventional glass, rather than the hard-to-obtain RE-10.

• **New potting technique** — Problems were encountered by the developers in lens mounting. Design requirements demanded that the lens assemblies be tested completed over the temperature range from −30 to 190 degrees F and through moderate vibration and rough handling.

It was determined to put lenses within mating steel rims. The clamping rings were soldered to make the assembly rigid.

Lenses were then centered within a cylindrical mount to within 0.0002 in. and each rim was soldered to the cell.



EIGHT-ELEMENT LENS SYSTEM as used in final design of new ballistic camera. The system, developers say, has less than 25 microns of radial distortion and less than 5 microns of tangential distortion.

LENS CELL is centered in the main lens frame for soldering. A reticle in the element center is sighted for alignment. Setscrews about main frame secure cell for soldering.

TECHNICIAN CENTERS a reticle on lens element. Lens, set on three ball bearings, is rotated to find center of top and bottom surfaces. Reticle will be emplaced with wax on top.

Strain was constantly observed in the glass with polarized light and indicators were used to detect element movement.

A hard polyester resin was first used, but under severe temperature tests cracks developed running from the resin into the glass edge to about 1/16 in.

A soft rubbery compound was found that was both hard enough to support the lens and soft enough to allow for the differential contractions of steel and glass at low temperatures. This approach met all stability requirements, developers said.

• **Shutter actuating system** — The shutter assembly employs 22 blades, 0.60 in. wide. An Armco steel shaft attached to each end of each blade serves as the core for each of the actuating solenoids. The solenoids are copper wound spools of molded nylatron (molydisulphide impregnated nylon) having an integral helical slot serving as a cam. A pin in each of the steel cores rides in the solenoid slots.

When the solenoid is energized, the core is pulled into the solenoid and the helical cam slot forces the blade to rotate through 90°. Inner row solenoids close the shutter; outer rows open it. To cancel out inertial forces, cams on every other blade are opposite hand.

Deceleration bumpers soften the stopping action after the blades have been energized. The cam-pin design and the fact that the blade is in tension during actuation minimize problems of blade whip and twist.

A single blade mockup has been life tested to over 350,000 cycles before failure. An improvement in blade design has apparently eliminated the failure cause.

• **Shutter control circuitry** — Circuitry is synchronized with the 24-v square-wave command pulse now used to actuate the capping shutter of the Wild BC-4 ballistic camera. The 10 μsec. rise time of leading edge of this 24-v pulse is used to construct opening trigger pulse for the shutter by feeding the pulse into a pulse transformer.

Closing trigger pulse is from trailing edge or fall time of the command pulse. Negative transients are eliminated by directing pulses through two diodes. Two clean positive pulses are the result.

Two distinct but identical circuits are used to operate the shutter system —one for opening, one for closing. Power source for each is a high current toroid power transformer. Primary input is 115-v, 60-cycle, 25-ampere.

A charged bank of capacitors connected across a silicon diode control operates the shutter assembly solenoid coils on discharge. Complete recharge requires 0.3 sec.

Repetition rates in a test assembly are variable from 1-13 exposures/sec. and exposure time can be controlled from 3-60 milliseconds.

• **Optical problems** — Secondary spectrum and other residual color aberrations with this system are quite significant because of the long focal length and large relative aperture employed in the camera design.

This is true of any 600 mm F2.0 system. Further, Nortronic scientists assert that secondary spectrum cannot be effectively reduced without limiting other performance requirements demanded of the ballistic camera lens. (The only configuration totally free of secondary color is a mirror system, which would not meet ballistic camera requirements.)

The effect of secondary chromatic aberrations is that the lens has some of the properties of a narrow bandpass filter. In addition, light not used in image formation is scattered over the film plane. In a proper filter it would be absorbed.

As a result of an extended study of the on-axis imagery characteristics of the 600-mm F/2.0 optical system, Nortronics determined that Class O or Class J emulsions would provide the best image recording results. The panchromatic characteristics of Class F emulsions proved to be detrimental to obtaining good images, although use of a 44-A filter would provide comparable results to that of the recommended film types. ■

RAIN

HAIL

THUNDER

LIGHTNING

ICE PELLETS, SLEET

HIGH DRIFTING SNOW

weather bird

Rain (••) hail (A) thunder (ᖇ) lightning (ᐸ) ice pellets, sleet (✱) high drifting snow (✚) are merely symbols on a weather map—not expected to be problems to the U. S. Army's SERGEANT missile system.

SERGEANT missile system's objectives are to be ready for action in the meanest weather, the most extreme temperatures and environments, at high and low altitudes. It can be checked out by one man with minimum training, emplaced and fired in a very short time by a six-man crew.

The land, sea and air-transportable SERGEANT system, produced for the Army by Sperry Utah—when it becomes operational—will take its place among the tough and dependable sergeants of U. S. Army tradition.

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names in the news

SALINE

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TANGEMAN

Col. Jack D. Koser (USAF-ret.) and **Lt. Col. J. A. Ogle (USA-ret.):** Join the staff of the director of long-range military planning, The Bendix Corp., Detroit, responsible primarily for long-range planning in their respective areas of interest. Koser formerly was chief of the advanced analysis branch of the Directorate of Development Planning, the Pentagon. Ogle's most recent assignment was a general staff officer with the Army General Staff, serving as project officer for the *Jupiter* and *Pershing* missiles, and as deputy chief, Missiles and Space Div., in the office of the chief of Research and Development.

R. E. Whiffen: With Bendix since 1946, appointed general manager of Bendix-Products-Aircraft Division, South Bend, Ind.

Charles E. Heitman, Jr.: A vice president and member of Bendix Corp.'s administration committee, assigned new executive responsibilities for the corp.'s Cleveland Instrument Co., Micrometrical Mfg. Co., and the Industrial Controls Section.

Joseph R. Carter and **Sacket R. Duryee:** Appointed directors of Wyman-Gordon Co., Worcester, Mass.

Charles F. McMorrow: Formerly with RCA, joins the General Mills Electronics Group, Minneapolis, as associate director for engineering in the Research and Development Department.

Dr. Edward B. Evans: Appointed research metallurgist with TAPCO, a division of Thompson Ramo Wooldridge, Inc., Cleveland. Evans formerly held an assistant professorship in metallurgy at Case Institute of Technology.

Walter J. Koshuba: Formerly with GE's Aircraft Nuclear Propulsion Div., joins The Beryllium Corp. as plant manager of the Nuclear Division, Hazleton, Pa. **Philip H. Snyder** promoted to plant manager of the Alloy Div., Reading, Pa.

Dr. Arthur D. Kirsch: Appointed director of a newly-created Life Sciences Div., Datatrol Corp., Silver Spring, Md. A prime aim of the new division will be to conduct research in areas where it is feasible to apply computer technology, with particular emphasis on the life and social sciences.

Raymond H. Herzog and **Harry Heltzer:** Elected vice presidents, Minnesota Mining & Manufacturing Co., St. Paul. **E. J. Kane, A. H. Redpath** and **R. W. Adam** elected divisional vice presidents.

Lawrence B. Miller: Promoted to manager-manufacturing administration and plant facilities for General Electric's Industry Control Dept., Salem, Va. **Dr. Lindon E. Saline** appointed manager of Specialty Devices Operation of GE's Defense Systems Dept., Syracuse, N.Y.

Dr. K. O. William Sandberg: Named assistant to **William M. Smith,** vice president and manager of Aerospace-Rockets Division, Textron's Bell Aerosystems Co., Buffalo, N.Y. Dr. Sandberg formerly was executive vice president and general manager, Norton Laboratories, Inc. **Charles H. Kenerson** named director of marketing of the Aerospace-Rockets Division.

Henry A. Samulon: Named associate director of Electronics Div., Space Technology Laboratories, Inc., Los Angeles. **Dr. Joseph F. Shea** succeeds Samulon as director of the technical team heading STL participation in the *Bambi* program.

Donald B. West appointed to newly-created position of associate head, Antenna and Microwave Section, STL's Communications Laboratory.

Dr. Theodore K. Steele: Named executive vice president of Bulova Research & Development Laboratories Division of Bulova Watch Co., Inc., Woodside, N.Y. Dr. Steele succeeds **Mell A. Peterson,** recently appointed special assistant to **Kenneth E. Fields,** company executive vice president for non-consumer product activities.

Lt. Col. Martin L. Raines: Appointed chief of the U.S. Army Rocket and Guided Missile Agency's Pacific Field Office on Kwajalein Island.

James W. Bryan: Promoted to West Coast area manager, Beech Aircraft Corp.'s Aerospace Div., Los Angeles. **G. R. Miller** named manager, San Diego area.

Gerald A. Tangeman: Elected assistant secretary and assistant treasurer, United Electronics Co., Newark, N.J., a subsidiary of Ling-Temco-Vought, Inc. Tangeman succeeds **Douglas C. Bevins,** who has retired.

Bruce F. Powers and **Howard L. Wiener:** Join the Washington, D.C. research staff of the Operations Evaluation Group (OEG), part of the Division of Sponsored Research, Massachusetts Institute of Technology.

John J. Connolly: Named vice president and general manager, Data Systems Div., Litton Industries, Inc., Los Angeles. **W. Dewey Clower** named applications engineer, Millimeter Wave Tubes, Electron Tube Div., Litton's Washington, D.C., office.

Brooks T. Morris: Appointed special assistant for reliability assurance, California Tech's Jet Propulsion Laboratory, Pasadena. Morris formerly was director of the Propulsion Div., The Marquardt Corp., in charge of missile engine development.

Lt. Col. Russell W. Ernst, USA: Named acting chief of the technical and industrial liaison office of the Office of the Chief of Research and Development in the Pentagon. Col. Ernst succeeds **Col. Jackson E. Shirley** of the Army General Staff, who retired recently after 21 years of service.

Ralph E. Rhoads: Former general counsel for Servomechanisms, Inc., joins Radio Corporation of America's West Coast Missile and Surface Radar Division, Van Nuys, as manager, contracts administration and marketing services.

Robert C. Lockwood: Formerly in charge of planning of development programs, named executive vice president of Instruments for Industry, Inc., Hicksville, N.Y. Lockwood also is a director of the company.

Lockheed Backing Gives GCR Boost in Lunar Contest

THE RACE for the lunar solid-booster contract is taking on a new complexion with Lockheed Aircraft Corp.'s complete acquisition of Grand Central Rocket.

GCR—with Lockheed's resources, management and sales know-how behind it—may now move from a "dark horse" position into top contention. The move is encouraging GCR officials to hope for a major slice of the big booster work.

Lockheed President Courtland S. Gross, in announcing the cash purchase (the amount was not disclosed), said last week it was a "logical step."

While it was obvious that GCR will give Lockheed an all-around capability, there was no indication how the acquisition will fit specifically into Lockheed's corporate plans. Timing of the move, however, seems to dovetail pretty much with NASA's *Apollo* program, which is still in the process of getting off the ground. Major contractors for both propulsion and the spacecraft are not expected to be selected until the first of the year.

Lockheed acquired a 50% interest in the Redlands, Calif., firm last year. The agreement completing ownership was worked out with Petro-Tex Chemical Corp., which is owned jointly by FMC Corp. and the Tennessee Gas Transmission Co. Grand Central had sales of $9.5 million last year.

Gross said GCR will operate as a division with Burt C. Monesmith, corporate vice president of manufacturing, as president and general manager. Dr. Cledo Brunetti, who had headed GCR, resigned earlier this summer to take another post in industry. The chairman of GCR is Maj. Gen. John W. Sessums, who retired as vice commander of ARDC (now Air Force Systems Command) in 1960.

Officials connected with the company indicated that there would be "no serious management changes."

GCR recently reported the purchase of a large desert area for a big booster development and test area. Some industry observers have noted that the company had seemed to have its future tied to one product—big solids—and if it failed to get some of this business it would be in real difficulty.

As part of Lockheed, it will now be able to diversify. ¤

Boeing's Solar Concentrator

PROTOTYPE DISH-SHAPED mirror may provide key to efficient electric power source for long-term spaceflight. Reflecting surface is composed of vacuum-deposited layer of silicon monoxide and aluminum. Boeing-developed prototype weighs 16½ lbs.

GENERAL ELECTRIC CORP. established a new Business Development Planning Organization.

The group will prepare and issue company business plans for future undersea warfare, missile defense and aerospace defensive systems, as well as radar, underwater acoustic, signal processing and display and specialized communications equipment.

The organization's three main functions will be;

—Technological Applications and Analysis

—Market Research and Planning

—Advance Business Planning.

GULTON INDUSTRIES, INC. acquired the Mervyn Sound and Vision Co., Ltd. a British scientific research and manufacturing company. Gulton president Dr. Leslie Gulton said the transaction was completed for a sum in excess of $500,000.

AIR PRODUCTS, INC., Allentown, Pa., has changed its name to Air Products and Chemicals, Inc.

The company has also acquired the business and assets of Delta Oxygen Co., Inc., Memphis, Tenn.

SPACE EQUIPMENT CORP., Torrance, Calif., is constructing a new headquarters. The first unit, scheduled for completion Oct. 1, will house the company's offices, engineering department and research labs.

WYLE LABORATORIES acquired the stock of Ransom Research Inc. and Ransom Systems through an exchange of stock.

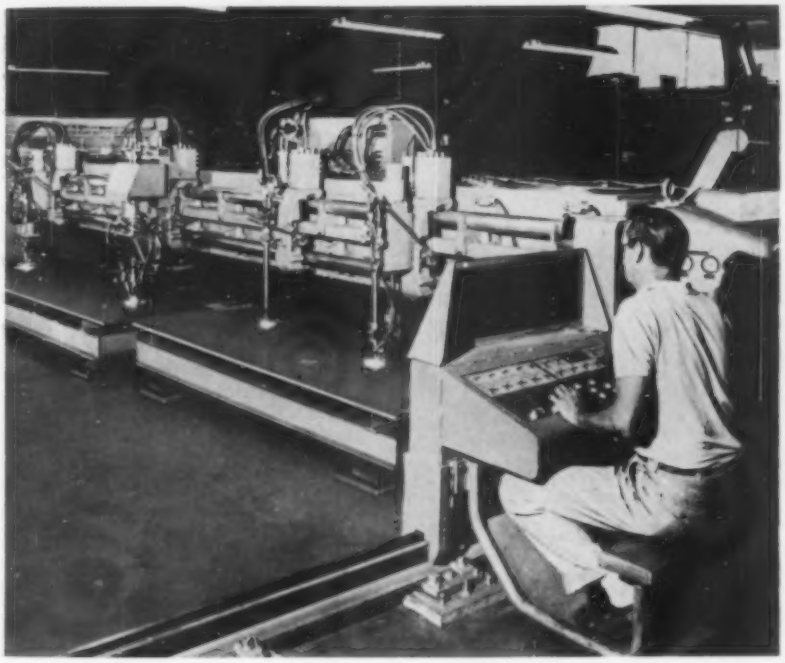
The Ransom companies specialized in design and manufacture of solid-state digital systems and components for aerospace GSE and for industrial applications. Most recent system installation provides complete data reduction facilities at CalTech's JPL for use in the NASA *Ranger* program.

CHRYSLER CORP'S Missile Div. has acquired new facilities in Melbourne, Fla., in a move to expand its engineering, manufacturing and range suport operations in the Cape Canaveral area.

COLLINS RADIO CO. consolidated its two electronic component operations into a single division, the Communications Accessories Co.

Affected are the mechanical and crystal filter facility, Santa Ana, Calif., and Communications Accessories Co., Lee's Summit, Mo.

Combined product lines of the new divisions include toroidal coils and transformers, laminated transformers, magnetic amps, ferrite products and LC, mechanical and crystal filters.



Tape-Controlled Flame-Cutter

The first numerical-control tape flame-cutting machine, developed by Air Reduction Sales Co. in cooperation with General Electric Co., is an automatic rectilinear bridge type unit capable of cutting straight lines and contours in plate of any length, 22 ft. wide and up to 6 in. thick. The machine eliminates the need for templates and template tables, and for an operator to control the flame-cutting process. The cutting system consists of two main components—the director—a General Electric Mark Century Numerical Contour Control System, and the cutting machine proper. The unit provides fully automatic control of flame-cutting operations by means of predetermined, numerically coded instruction.

Circle No. 225 on Subscriber Service Card

Shielded Loop Antenna

Aerospace Research, Inc. has developed a balanced, self-supporting, electrostatically shielded loop antenna ruggedly designed for outdoor installation in any environment. The L-I Loop Antenna has been specifically developed for use at low and very low frequencies where electrostatic shielding is usually necessary for proper reception. The loop can be used for calibrated measurement as well as for normal reception. The antenna has a diameter of one meter and is provided with a universal mounting bracket.

Circle No. 226 on Subscriber Service Card

Solid Tantalum Capacitors

Texas Instruments Inc. has announced the expansion of its line of tan-TI-cap solid tantalum capacitors. Twenty-eight new low-capacitance ratings, 0.0047 μf through 0.82 μf, bring the number of standard capacitance-voltage-tolerance ratings of TI's electrolytic capacitors to over 250. Packaged in the small-type SCM "F" case, these miniature capacitors are available in 20 v or 35 v d-c voltage ratings. They are offered in ±10% and ±20% tolerances and 10% decade ratings; other tolerances available on special order.

Circle No. 227 on Subscriber Service Card

No-Lube Sleeve Bearings

Self-lubricating sleeve bearings, which will be marketed under the trade name of Neverlube, are available from Carter Manufacturing Co. The design is a machined-steel outer sleeve or cartridge in which an oil reservoir, in the form of internal grooves, has been provided. The oil reservoir is filled with a special oil during assembly of a sintered bronze bushing. Capillary action of the oil in the reservoir through the sintered bushings provides a continuous oil film between the assembled bearing bore and shaft for a substantial period of operation.

Circle No. 228 on Subscriber Service Card

Miniaturized Switches

Miniaturized telemetering commutators, averaging 60% smaller and 50% lighter than previous IDL standard models, have been put on the market by Instrument Development Laboratories, Inc. These miniaturized commutating switches have been operated under environmental conditions without drop-out, noise, bounce or signal contamination. One model equipped with the new IDL clamped speed regulator weighs 17 oz., has a power consumption of 150 ma at 27 vdc, and is reported to provide frame rate stability of better than ±3%.

Circle No. 229 on Subscriber Service Card

Chevron Baffle-Cold Trap

NRC Equipment Corp. has introduced a complete line of optical baffle-cold traps for vacuum pumping systems. The traps feature a circular chev-

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ron design with the coolant reservoir centrally located in the assembly. The baffle-cold traps are optically opaque, which means that gas or pumping vapor molecules, which travel in straight lines at high vacuums, cannot pass through the assembly without striking a baffle surface.

Circle No. 230 on Subscriber Service Card

Automatic Testing System

A system which digitally measures the elapse time between any two points on a high-speed waveform is available from Dymec, a division of Hewlett-Packard Co. The DY-5844 automatic waveform-measuring system will measure time intervals between any two points chosen from the 0—100% level of either stimulus or response pulse. Accuracy is better than ±4% of full scale, ±0.4 nonoseconds. In addition to measuring transistor, delay, rise, storage, and fall time, the DY-5844 will make similar measurements on diodes, magnetic cores, and high-speed components and circuits.

Circle No. 231 on Subscriber Service Card

Correction

M/R, Sept. 4, printed this photo of Avco's new plasma gun sans story (below).

A compact, lightweight plasma gun designed for industrial use is in production at Avco Corp.'s Research and Advanced Development Division. Only 5 in. long and weighing 3½ lbs., the entire gun assembles with only four bolts securing precision-machined, self-aligning, piloted parts. Its makers say it will spray coating—including refractories—with a controlled thickness, density, and bond strength that could never be obtained before. It reportedly deposits a coating at twice the rate of comparable competitive models, and at savings up to 30% over existing coating processes such as oxyacetylene flame-spraying.

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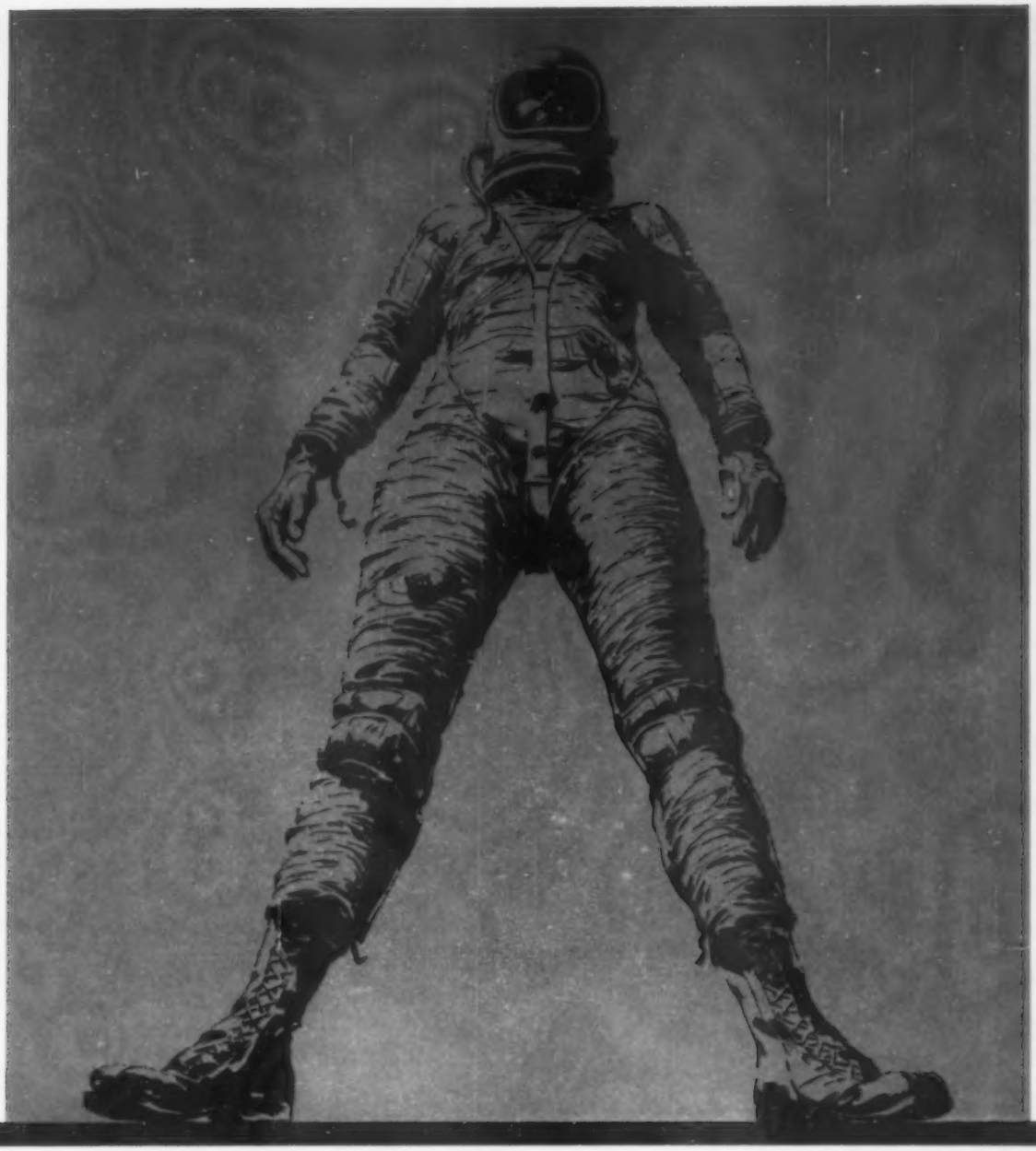

STANCE: Litton Systems Advance the Defense Posture of the Free World

The need is urgent. It will be met. By free men acting with renewed faith. Armed by advanced in-being systems such as those to be displayed at the Litton Systems booth at the Air Force Association show this month. You are invited to see them. To study the Litton record of system management and technical creativity for USAF and other defense forces of the free world. To evaluate the meaning of that record in relation to our present and future defense posture.

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BEVERLY HILLS, CALIFORNIA
A DIVISION OF LITTON INDUSTRIES

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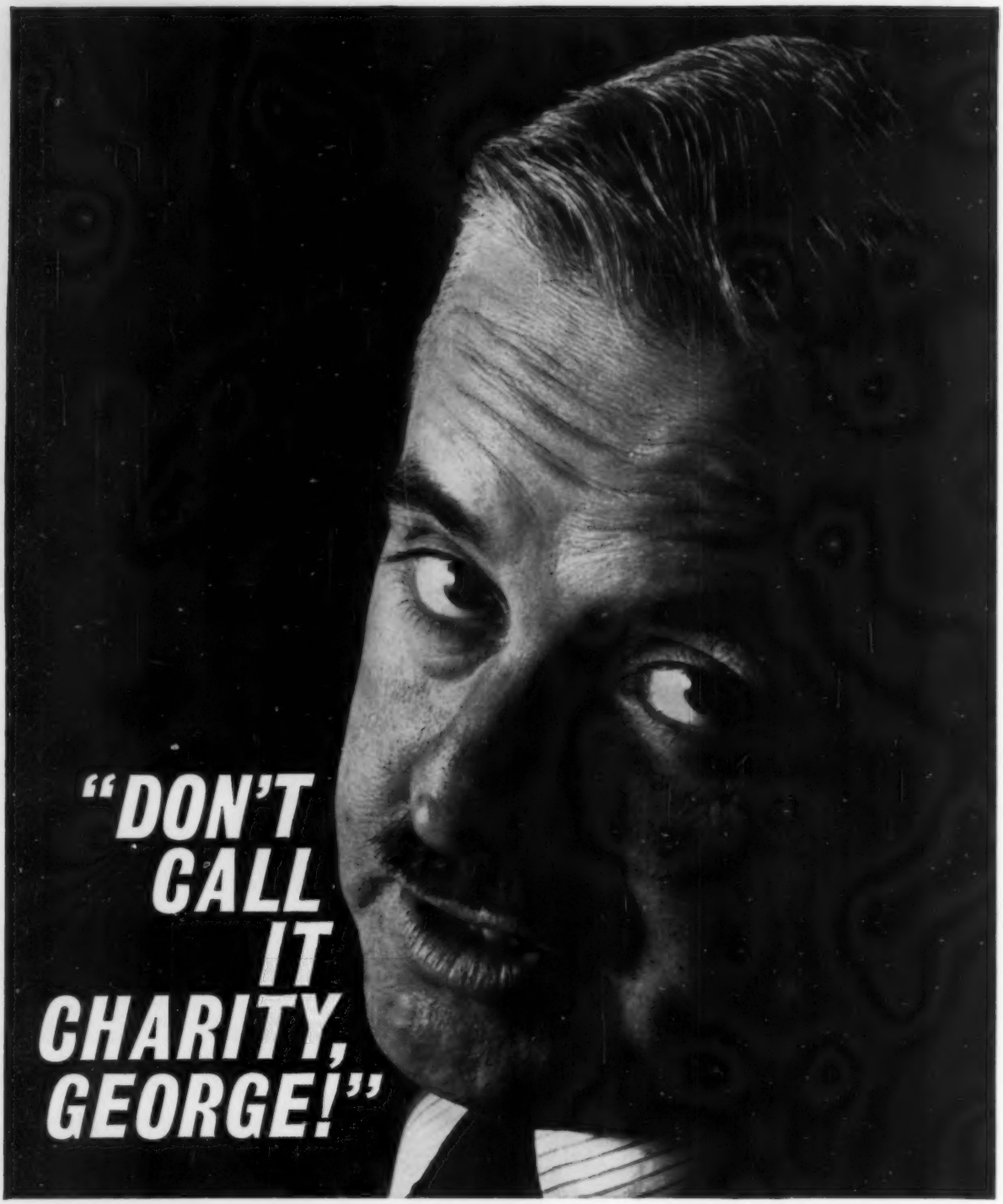
The spectrum of systems career opportunities is broad at Litton. All qualified applicants will be considered regardless of race, creed, color or national origin.



"Contributions to the United Fund are really investments! Sure, charity takes the edge off hunger and misery. And that's necessary. But the agencies of the United Fund go way beyond that. They give the help that gets people back on their feet, makes them productive members of the community again. So it makes good sense to give the United Way—as an investment in a stronger, more prosperous community. Besides, that's the American way: to take care of our own, right at home. Our company makes a contribution, urges its employees to join in and makes it convenient through payroll payments. This once-a-year appeal cuts down the confusion of separate drives, too. It's more than a charity, George. It's an investment—and a duty—for your business and mine!" **GIVE THE UNITED WAY**

Army Gets BIRDIE

(Continued from page 21)

updating of target position and velocity data. While this version of the system is capable of coordinating and directing many fire units, the GSG-6, routing externally-generated data and/or locally-generated pointing data, can only manage the activities of a limited number of units.

The electronic, semiautomatic air defense coordination system consists of the air defense radar, communication and data transmission links, visual display consoles on which the area aircraft situation is displayed, computers and fire unit integration facilities and primary and secondary power supplies. The entire system is housed in standard Army shelters, 18 ft. long, 8 ft. wide and 7½ ft. high, and is transportable by air, rail or road.

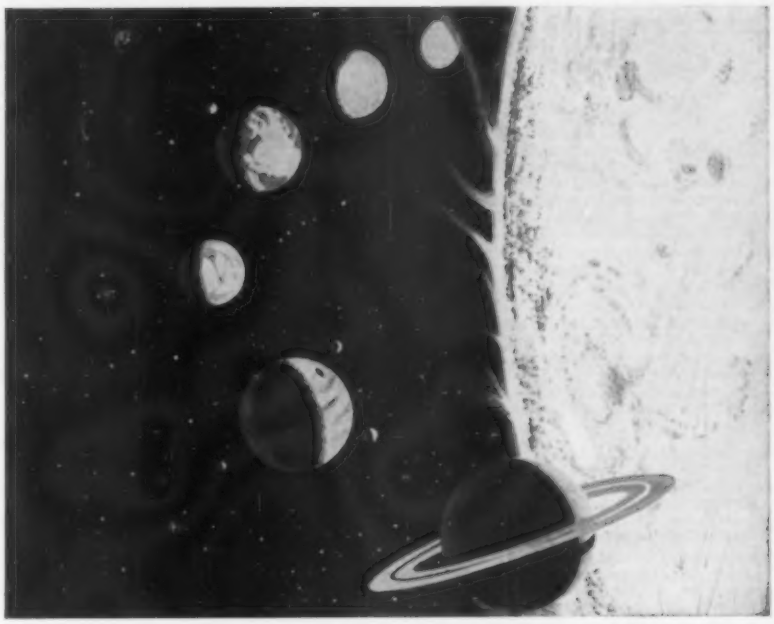
One of the prime factors in the reduction in size for the BIRDIE system is the use of approximately 3000 transistorized printed-circuit cards which make up the heart of the digital data processing system. By careful planning, the more than 12,000 digital circuits have been arranged so that they can be produced almost on a mass-production basis—at 1/15th the cost of producing these cards in the past.

• **Highly flexible**—To illustrate the flexibility of the system, engagement evaluation, aircraft identification and target assignment can be made by either the higher headquarters or the BIRDIE coordination center.

Using automatic digital data communications, the system receives from higher headquarters the track position, velocity and auxiliary data, and transmits the battery track position and auxiliary data in addition to battery repeat-back data, target reference and target designation data. In the continental U.S. these data links are Bell A-1 data service with higher commands and AN/TSQ-8 type service with the fire units.

The primary power for the system is furnished from commercial or standard military generators producing 120/208 volt, three-phase, four-wire, 60-cycle power. The load requirement for each of the three shelters is: 8 kw. for the equipment shelter; 9 for the one-console and equipment shelter; and 3 for the two-console shelter.

Operating in an environment from −40°F to +125°F, the system requires no site preparation prior to installation. All inputs and outputs are terminated at a demarcation panel for maximum flexibility. ⌗



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Continued expansion of our aerospace systems programs has created additional openings for highly qualified engineers and scientists to participate in company studies on many advanced projects. Challenging positions now exist in the following areas of specialization:

AEROTHERMODYNAMICS RESEARCH SCIENTISTS To perform both theoretical and experimental studies in the field of hypersonic and rarefied gas dynamics with emphasis on the re-entry flight regime. Opportunities available to participate in planning and/or development of company research facilities. Advanced degree required. Several openings.

AERODYNAMICS ENGINEERS To perform aerodynamic analyses on advanced configurations for lift, drag, stability, control, loads, and heat transfer. Familiarity with subsonic and supersonic aerodynamic theory required. Familiarity with wind tunnel testing desirable. Openings exist at all levels, but major requirement is for senior men capable of assuming complete responsibility for a major program and/or supplying expert consultation to advanced design studies.

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For additional information, please address a resume or letter of inquiry to:
Mr. B. J. Cunningham, Manager, Employment Services,
12214 Lakewood Blvd., Downey, California

All qualified applicants will receive consideration for employment without regard to race, creed, color, or national origin.

SPACE & INFORMATION SYSTEMS DIVISION
NORTH AMERICAN AVIATION

contracts

NASA

$348,643—**S&Q Construction Co.**, San Francisco, for test-section components and auxiliary piping systems for the mass transfer cooling and aerodynamic facility, Ames Research Center, Moffett Field, Calif.

$310,000—**The Martin Co.**, Baltimore, for production of heat exchanger units for *Saturn C-1* boosters.

$183,875—**Electronic Associates, Inc.**, Long Branch, N.J., for computer system for Lewis Research Center, Cleveland.

$49,000—**FluiDyne Engineering Corp.**, Minneapolis, for designing aerodynamic components for an arc-driven hypersonic wind tunnel, **Research Center, Langley, Va.**

MISCELLANEOUS

$750,000—**The Bendix Corp.'s Industrial Controls section**, Detroit, from **Douglas Aircraft**, for transistorized tape-controlled contouring systems for machine tools.

$370,000—**Vehicle Research Corp.**, Pasadena, Calif., from Maritime Administration, for design of a "surface effect ship" which would travel above the water on a cushion of air at speeds of 100 mph or more. **Douglas Aircraft Co.** will be the major subcontractor and presumably the builder of the ship.

$146,500—**FluiDyne Engineering Corp.**, Minneapolis, for design, fabrication and erection of a rocket test facility; $50,000 for research for flow studies of rocket motor exhaust gases, both from **Hercules Powder Co.**

$32,000—**FluiDyne Engineering Corp.**, Minneapolis, from **North American Aviation**, for fabrication of hypersonic wind tunnel nozzles.

NAVY

$2,500,000—**Gould-National Batteries, Inc.**, St. Paul, for production of submarine batteries.

$1,650,000—**Stanford University**, Palo Alto, Calif. from ONR, for continuation of a Navy-Air Force program supporting basic studies of the nuclear structure and properties of the elementary particles of nature.

$1,033,000—**Reaction Motors Div., Thiokol Chemical Corp.**, Bristol, Pa., for production of Model LR 62 RM-2 packaged liquid rocket engines for the *Bullpup B* air-to-surface missile.

$850,000—**Packard Bell Electronics Corp.**, Los Angeles, for airborne recorders used in antisubmarine warfare and for an automatic checkout system for a French ballistic missile.

$270,000—**Electro Steel Structures, Inc.**, and **Western Erectors, Inc.**, Rialto, Calif., for construction of a *Scout* launch complex at Naval Missile Facility, Point Arguello, Calif.

$155,242—**General Electric Co., LMED**, Ithaca, N.Y., for design, development and fabrication of an airborne infrared vidicon system suitable for radiometric and spectrometric measurements of target characteristics from an airborne platform.

$120,000—**Douglas Aircraft Co.**, El Segundo, Calif., from BuWeps, for an 18-month study of thermoelectric power system using waste heat from jet or rocket engines for both electrical power and cooling.

Westinghouse Electric Corp., Lester & E. Pittsburgh, Pa., for development and production of a 400-cycle turbine-generator and related switchgear to provide power for the *Typhon* weapon system. No amount disclosed.

ARMY

$21,000,000—**The Martin Co.**, Orlando, for continued work on the *Pershing* missile system.

$6,433,884—**Hercules Powder Co.**, Radford, Va., from Ordnance Ammunition Command, Joliet, Ill., for work in propellants and explosives.

$1,728,891—**Raytheon Co.**, Waltham, Mass., for concurrent repair parts and modification kits for the *Hawk* missile system. 2 contracts.

$1,250,000—**Continental-Emsco Co.**, Dallas, a division of **The Youngstown Sheet and Tube Co.**, for delivery of 57 sets of wheel truck assemblies for all *Titan II* ICBM sites.

$475,000—**Adler Electronics, Inc.**, for production of three transportable AN/TSC-20 communications centrals.

$191,291—**Western Electric Co.**, New York City, for procurement of *Nike* replenishment spare parts and repair parts. 2 contracts.

$56,500—**Armour Research Foundation, Illinois Institute of Technology**, Chicago, from Signal Corps, for development of a new high-temperature solar cell.

AIR FORCE

$10,935,000—**Allison Div., General Motors**, Indianapolis, from **Thiokol Chemical Corp.**, for production of first-stage rocket engine cases for the *Minuteman* ICBM.

$3,140,000—**Sperry Gyroscope Co.**, Great Neck, N.Y., for installation and on-site verification testing of AN/FPS-35 radar set.

$1,090,614—**Hughes Aircraft Co.**, Culver City, Calif., for partial production of infrared sight systems.

$1,500,000—**Sylvania Electric Products, Inc.**, New York City, for production of miniature and subminiature electron tubes.

$600,000—**Motorola, Inc.**, Chicago, for QRC-170 transportable jammer.

$449,999—**Bendix Corp.'s Support Equipment Div.**, Teterboro, N.J., for product improvement for the AN/GJQ-9 sequency programing sets.

$442,950—**North American Aviation, Inc., Rocketdyne Div.**, Canoga Park, Calif., for administrative documentation and other support under WDT Exhibit 57-2 for provisioning of initial spare parts for the WS107A-1 propulsion system and related AGE.

$378,000—**The Boeing Co.**, Seattle, from AFSC, Edwards AFB, for applied research and testing on problem areas which will be encountered in the development of 1- to 9-million-lb.-thrust booster propulsion subsystems and to initiate selected programs toward the solution of critical problems.

$188,907—**Airborne Instruments Lab.**, Long Island, N.Y., for AN/GPX-27 interference blanker group.

$132,971—**J&H Smith Mfg. Co.**, Newburgh, N.Y., for airborne training rocket launcher, Type MA2A.

$94,728—**Electro-Optical Systems, Inc.**, Pasadena, Calif., from Rome ADC, for development of advanced laser components for use in optical surveillance systems.

$31,000—**McCormick Selph Associates**, Hollister, Calif., from Lockheed Missiles and Space Co., for design of dual-carriage explosive bolt for *Discoverer* program.

LFA

PRECISION - Square, Flat and Rectangular Wire with Controlled Edges

For **WELDED** electronic circuitry, for **WIRE-WRAP** and **PLUG** or **PIN** type **CONNECTORS** for computors, control systems, missiles, etc., also for springs, terminals, forms, fittings, prongs, contacts and clips.

Silvercoate ® Beryllium Copper — Brass — Bronze — ni-clad-ti Titanium — Aluminum — Hot Solder Dipped — Tinned — etc.

Square and rectangular shaped wires are frequently used in modern "wrapped" terminal and pin or plug type connectors. For this application the edges must be finished quite sharp (usually .003 radius corners or less) but without a burr or flashing. Also required are **closely controlled dimensional tolerances** and smooth finish. Uniformity of temper is essential. Therefore close control of all facets of wire manufacturing is of paramount importance.

LITTLE FALLS ALLOYS, INC. 189 CALDWELL AVENUE, PATERSON 1, NEW JERSEY

—when and where—

SEPTEMBER

Fall Instrument-Automation Conference and Exhibit and 16th Annual Meeting, Instrument Society of America, Biltmore Hotel, Los Angeles, Sept. 11-15.

Fall Conference, Electronic Industries Association, Biltmore Hotel, New York City, Sept. 12-14.

International Operations and Maintenance Symposium, Airwork Corp., Millville, N.J., Sept. 13-14.

Technical-Scientific Communications Conference, IRE, Bellevue-Startford Hotel, Philadelphia, Sept. 13-15.

16th Annual Meeting of Armed Forces Chemical Association, Statler-Hilton Hotel, Washington, D.C., Sept. 13-15.

Symposium on Materials in the Space Age, Aeronautical Systems Division of the AFSC (invitation only), Phoenix, Ariz., Sept. 13-15.

9th Annual Joint Societies Engineering-Management Conference, IRE, Hotel Roosevelt, New York City, Sept. 14-15.

Conference on Technical-Scientific Communications, IRE, Bellevue-Stratford Hotel, Philadelphia, Sept. 14-15.

16th Detroit Quality Control Forum, co-sponsored by Greater Detroit Section of American Society for Quality Control and University of Michigan, Angell Hall, University of Michigan, Ann Arbor, Sept. 16.

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Anti-Gravity Devices

(Continued from page 31)

In the electromagnetic case, the current I through the wire causes a magnetic field B in the torus. If the current is constantly increasing, the magnetic field also increases with time. This time-varying magnetic field then creates a dipole electric field E (see Fig. 1a).

In the gravitational analog the mass flow T through a pipe wound around a torus, causes a field P in the torus. If the flowing mass is accelerated, then the P-field increases with time. This time-varying P-field then creates a dipole gravitation field G (see Fig. 1b).

Unfortunately, since the "gravitational permeability of space" has the very small value of $\eta_0 = 3.73 \times 10^{-26}$ meters per kilogram, it would require very large systems to obtain even a measurable amount of gravitational acceleration, much less anti-gravity.

For example, if it were somehow possible to create and contain matter with the density of a dwarf star, and if we could somehow accelerate it through pipes wide as a football field wound around a torus with kilometer dimensions, then we would create a gravitation field at the center of the torus of about $G = 10^{-10}a$, where a is the amount of acceleration we can give the dwarf star material.

If it were then somehow possible to generate enough force to accelerate all this mass at 10^{11} meters per sec^2, then we could counteract the earth's gravitation field for a few milliseconds. The reason for this time limitation is that at an acceleration of 10^{11} m/sec^2, it takes only a few milliseconds to reach the speed of light.

• **Future lines of attack** — It is obvious that the minimum material and force requirements for this particular model are so far from present capabilities, that unless a major brekthrough is made practical anti-gravity will be technologically impossible for centuries.

Since the strength of all the gravitational effect depends directly or indirectly on the density of the material, the best area for future research in gravity is in super-dense materials. We know the materials exist since a large percentage of the stars in the sky are dwarf stars. These dwarf stars have the same mass as the sun, but their volume is comparable to the earth. The densities have been estimated to be around 10^8 to 10^{12} gm/cc.

Whether such "collapsed matter" can be made, and whether it can be kept stable once made, are difficult questions that cannot be answered without much more research. ⌗

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editorial . . .

The Death of a Citizen

WE ADMIRED and respected him always. His quiet strength and his vision were an asset not only to the company he guided but to the entire nation.

The passing of Robert E. Gross leaves us all poorer.

Our first connection with the Lockheed board chairman was a remote but intensely personal one. We flew one of his P-38's. It was a fine airplane. The test pilots he sent out to work with the squadrons were fine men.

The personal contact of later years did nothing to change the respect arising out of our wartime experiences. The informative, almost scholarly discussions with the man in the Lockheed front office always left a deep impression. Mr. Gross was a gentleman in the truest sense of the word. He also was a gentleman who knew what was happening in his company and where it should be going. Lockheed's transition into the missile/space industry was under the leadership of a man who looked to the future and drew thoughtful conclusions from what he saw there.

"You look ahead, not back," he once said. "You look ahead where the horizons are absolutely unlimited."

That philosophy carried the company to its prominent position in the new field of missiles and space. The *Polaris* missile and the *Agena* space vehicle are but two manifestations in hardware of that wisdom.

When Mr. Gross and a group of associates purchased the assets of Lockheed in June, 1932, the bankrupt company then had less than 60,000 square feet of rented factory space. Today, it is America's 28th largest industrial firm, a 16-million-square-foot industrial giant with 66,500 employees, net assets of $548 million, and yearly sales of better than $1 billion.

It is a leader in missiles, space and related fields, respected throughout the world for its accomplishments.

But it was not only for his part in that amazing growth that Robert Gross was known. He was not only a business man; he was, in the most unobtrusive way, a citizen.

University of California President Clark Kerr called him a "civic leader with a deep sense of human values."

To know something of the kind of man he was, it is necessary only to look at his achievements outside the company. He was a trustee of The Boys Club of Southern California, a member of the board of the Arthritis and Rheumatism Foundation, chairman of the United States Savings Bond Campaign in 1957, vice chairman of the United Community Campaigns of America, a member of the boards of The Good Samaritan Hospital in Los Angeles and The Children's Hospital in Boston, a member of the Art Council of the University of California at Los Angeles, and an overseer of his own alma mater, Harvard.

He was named California Industrialist of the Year in 1959. He was president of the Institute of Aeronautical Sciences in 1955. In June of this year, he was cited by the National Conference of Christians and Jews for his personal service in the cause of good brotherhood.

The Lockheed plan to broaden opportunities throughout the company for employment and advancement of minority groups was called by President Kennedy "a milestone in the history of civil rights."

Lockheed is a leader in employment of handicapped workers, in funding scholarships for worthy students, in sponsoring medical research.

At the same time, it is known as a hard fighter for contracts. Ask anyone who tangled with the company when it was selling the F-104 to Europe. Several British and U.S. firms still are rubbing their bruises.

ALL OF THIS is a tribute to the quiet man who was chief executive officer and board chairman. And now he is gone.

We last saw Robert Gross some weeks ago here in Washington. During our brief chat in a hotel lobby, his handshake was firm and his eyes were clear.

The closing of those eyes has cut off a vision that will be sorely missed by his company, his industry and his country.

Perhaps the finest obituary for Robert Gross may be found in a speech he himself made in San Francisco last February.

"We have soared above into the clear colorless regions of space where the 'white radiance of eternity' is unstained and where truth may be found pure and undistorted. It is my hope that our penetration of space will bring this white radiance into the lives of all of us and that our expanding knowledge of the universe will be matched by an increasing knowledge of how to live with each other."

Hail and farewell.

William J. Coughlin

HW14

Kaylock® 'captive washer' nut gains wide acceptance!

Since its introduction early in 1960, this new Kaylock® lightweight, all-metal self-locking nut with integral free-spinning metal washer has been specified by leading aerospace manufacturers for an increasing number of applications. Separate washers that used to drop off, roll away, and slide into hard-to-get-at places have been eliminated. The danger of short circuits, due to these forgotten washers, also has been eliminated by the new Kaylock HW14 nut-washer combination. Available in carbon steel or A286 corrosion-resistant steel.

Saves Assembly Time. Kaylock HW14's cut extra motion required to put washer on bolt. Washer can't drop off during application or removal. Cuts time lost looking for wayward washers..*to zero!* *Safer, too!* Kaylock HW14 "captive washer" nuts employ the same, sure elliptical locking principle to prevent vibration hazards. The Kaylock HW14 is a development of Kaynar Mfg. Co., Inc., world's oldest and largest manufacturer of lightweight, all-metal self-locking nuts. Write today for the new Kaylock HW14 Brochure—or call your nearest Kaylock representative.

The Kaylock HW14 is available in size -02 (shown above) and in other sizes to -6

View of Kaylock HW14-3 and washer prior to assembly.

Assembled HW14-3. Integral, free-spinning washer can't drop off. Only one part to handle instead of two.

Kaylock.
first in lightweight locknuts

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Box 2001, Terminal Annex, Los Angeles 54, Calif. Branch offices, warehouses & representatives in Wichita, Kan.; New York, N.Y.; Atlanta, Ga.; Renton, Wash.; Montreal; Paris; London; The Hague

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SCHOOLROOM FOR ASTRONAUTS

On America's drawing boards and in the laboratories are two, three and five-man spacecraft, space platforms and manned lunar craft. The goal is interplanetary flight. Eventually, lifetimes may be devoted to a single space adventure.

But man must conquer near space before he goes afar.

Ready to serve as the trainer for future astronauts is NASA's Project Mercury spacecraft. This compact, one-man vehicle now carrying the first Americans into space is an astromedical laboratory to test man's reactions to this new environment. But the Mercury spacecraft can easily serve as a readily available and efficient schoolroom for future astronautics students making their first leaps into space.

Months of ground training will be necessary for coming space explorers. Then will come trajectory flights to experience weightlessness and spacecraft control. Earth-orbital flights will acquaint the future astronauts with spacecraft control, celestial and ground observation, re-entry techniques, artificial atmosphere and other environment concepts.

Only after he has mastered the "one-room schoolhouse of the space age" will the astronaut be ready to man a deep space vehicle.

MCDONNELL

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